Zymate System
Service Manual

Volume 1

Zymark

Laboratory Automation
for Chemistry and Biotechnology

MAINTAINING THE ZYMATE I SYSTEM

TOOLS REQUIRED:

Screwdriver, blade, 1/8 x 4, 3/16 x 6, 1/4 x 6
Screwdriver, Phillips, #1, #2
Ball-end hex driver, 9/64
Wrench, hex (Allen), .050, 3/32, 9/64, 3/16
Wrench, open-end, 5/16
Digital Voltmeter (DVM)
Level

PREFACE:

The following preventative maintenance procedures should be used to assure that your system is functioning properly.

This procedure is organized into two sections:

1. MONTHLY MAINTENANCE AND PERFORMANCE CHECKS
2. QUARTERLY PERFORMANCE CHECKS - Includes the monthly checks

Any step having "_____" preceeding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Procedures for the replacement of parts are not provided as part of this section. Refer to the appropriate section within the Service Manual for parts replacement procedures as well as in-depth troubleshooting information.

PROCEDURE 1:
MONTHLY MAINTENANCE AND PERFORMANCE CHECKS

*** TURN SYSTEM POWER OFF ***

I. ROBOT

A. LUBRICATION

Clean the Zymate I Robot arm and posts with a Kimwipe® that has been dampened with 10W40 motor oil. Work the affected axis back and forth while wiping the arm or post with the oil. Leave the arm and posts coated with a THIN film of oil.

B. UNUSUAL SOUNDS

While operating each axis, listen for unusual sounds which may disclose bearing dirt, rubbing or binding, squealing bearings, broken gear teeth, etc. If noises seem to be coming from the arm or post bearings repeat step A.

C. CABLE TENSION

It is good practice to establish a "feel" for normal cable tension so that abnormal conditions can be promptly detected. Periodic checking of cable tension can detect a gradual deterioration of performance at an early stage.

1. REACH CABLE

a. Position the arm at mid-height.

Note: The REACH cable is the cable that passes through the HOLE in the cable retainer in the top of the white Delrin arm housing (See Figure 2).

b. Grasp the cable (vertical section) at mid-length above the arm housing (not below) and pull it sideways.

_____c. A force of approximately 2 lbs should move the center of the cable .20 to .25 inch (.5 to .6 cm).

CORRECTIVE ACTION **The cable tension can be adjusted with a 9/64 ball-end hex driver through a hole in the bottom-left side of the column cap as viewed from the wrist-end of the arm.**

1. **Turning the screw CLOCKWISE will reduce the cable tension. Figure 1 below illustrates the direction of the clockwise adjustment.**

2. **Turning the screw COUNTER-CLOCKWISE will increase the tension.**

3. **Adjust to the description in step 1c above.**

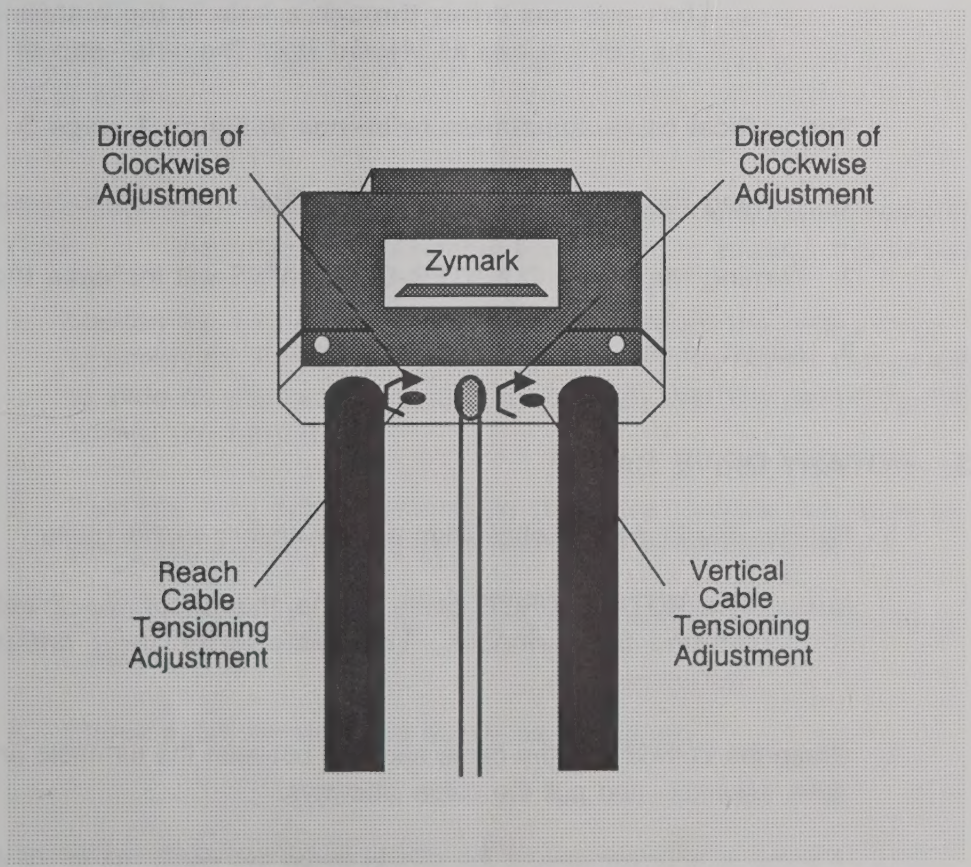

Figure 1

2. VERTICAL CABLE

a. Position the arm at mid-height.

Note: The VERTICAL cable is the one that passes through the SLOT in the cable retainer in the top of the arm housing.

b. Grasp the cable at mid-length above arm housing and pull it sideways.

___c. A force of approximately 2 lbs should move the center of the cable .20 to .25 inch (.5 to .6 cm).

CORRECTIVE ACTION **The tension on the vertical cable is higher than the reach cable because it supports the weight of the arm and arm housing. The cable tension can be adjusted with a 9/64 ball-end hex driver through a hole in the bottom-right side of the column cap as viewed from the wrist-end of the arm.**

See vertical cable adjustment reference in Figure 1, page 3.

1. **Turning the screw CLOCKWISE will reduce the cable tension.**
2. **Turning the screw COUNTER-CLOCKWISE will increase the tension.**
3. **Adjust to the description in 2c above.**

3. ROTARY DRIVE CABLE

a. Remove the Zymate I Robot skirts to gain access to this cable.

Note: The ROTARY DRIVE cable is the thicker of the 2 cables wound around the turntable. This cable is the most critical to rotary performance.

b. Grasp the LONGER of the cable sections between the turntable and the motor drive assembly and pull the cable sideways.

_____c. A force of approximately 2 lbs should move the cable .04 to .08 inch (.1 to .2 cm). This cable should feel tight.

CORRECTIVE ACTION **The adjustment of this cable appears to be simple but, if done incorrectly, the cable can be broken. Please refer to**

the Zymate Service Manual's Robot "Cable Adjustment" section, R65, if you feel an adjustment is necessary. Call Zymark with any questions you may have concerning this adjustment.

4. ROTARY SERVO CABLE

a. Remove the Zymate I Robot skirts to gain access to this cable.

Note: The ROTARY SERVO cable is the thinner of the 2 cables wound around the turntable.

b. Grasp either section of the cable between the turntable and the rotary pot servo assembly and pull the cable sideways.

_____c. A force of approximately 2 lbs should move the cable .15 to .20 inch (.4 to .5 cm).

CORRECTIVE ACTION **Adjustment of the rotary servo cable tension involves moving the rotary pot assembly away from, or toward, the turntable.**

1. **Loosen the two allen head screws that secure the rotary pot assembly to the baseplate just tight enough to permit the assembly to slide on the baseplate, but not enough that the assembly tips toward the turntable.**

2. **Turn the long adjustment screw that runs through the base of the rotary pot assembly to adjust the rotary servo cable tension.**

3. **After adjustment is made, retighten the two assembly mounting screws.**

4. **Check cable tension and adjust as necessary.**

D. REACH BEARINGS

The two arm (reach) bearings are adjusted with a small blade screwdriver through two holes located in the top of the arm housing, just above where the arm enters the front and rear of the arm housing (Figure 2). Turn the screw COUNTER-CLOCKWISE until it is snug. Then, turn the screw CLOCKWISE 1/8 turn.

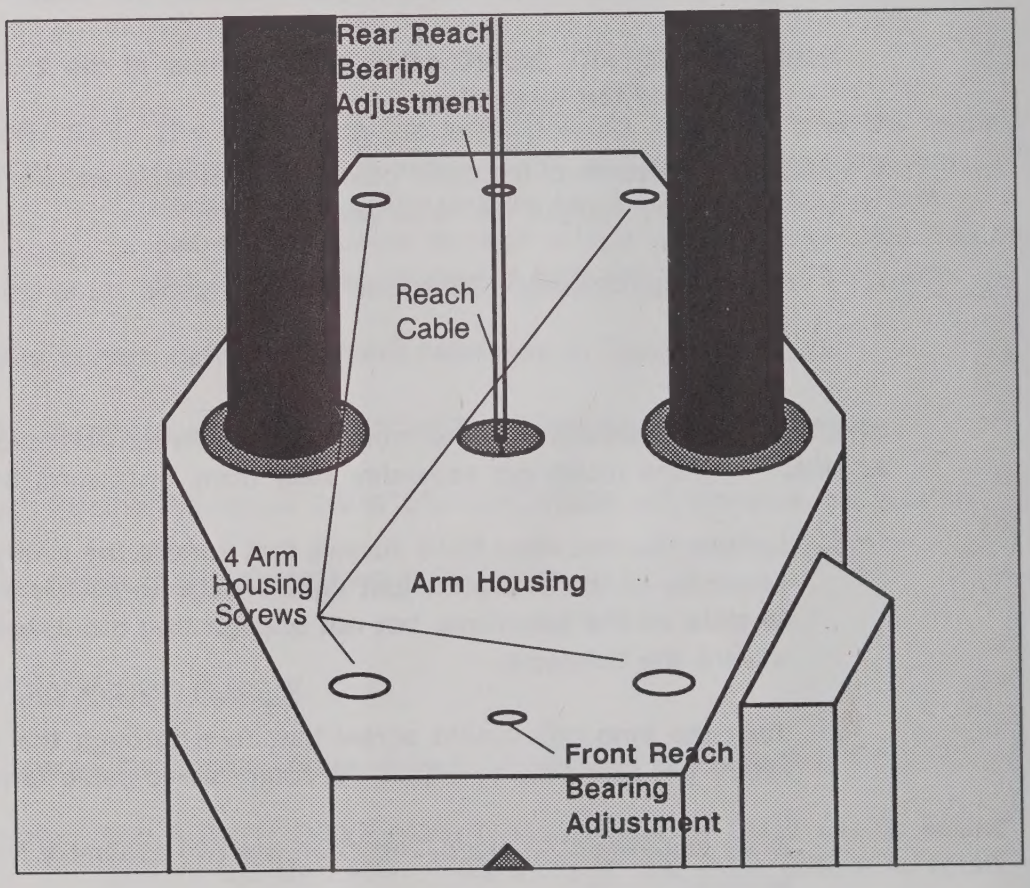

Figure 2

E. ZYMATE I ROBOT WRIST

Remove any hand attached to the wrist and check for any bent or displaced electrical pins within the wrist coupling cavity.

CORRECTIVE ACTION **Call Zymark Service for assistance.**

***** TURN SYSTEM POWER ON *****

1. WRIST SELF-RESTORING PLAY

a. Run a program to attach a SYRINGE hand (or a GP hand with a pencil in the fingers).

b. Manually rotate the hand (gently) in both directions until resistance is felt. Do not force wrist to rotate more than 1.5 degrees.

_____c. Verify that when released from both directions, the hand returns to the same position without overshoot.

CORRECTIVE ACTION **Call Zymark Service in the event of a wrist self-restoring play failure.**

2. WRIST ZERO

a. Using the Zymate I Robot teaching screen, move the wrist angle to 0 degrees.

b. Remove the hand from the wrist coupling.

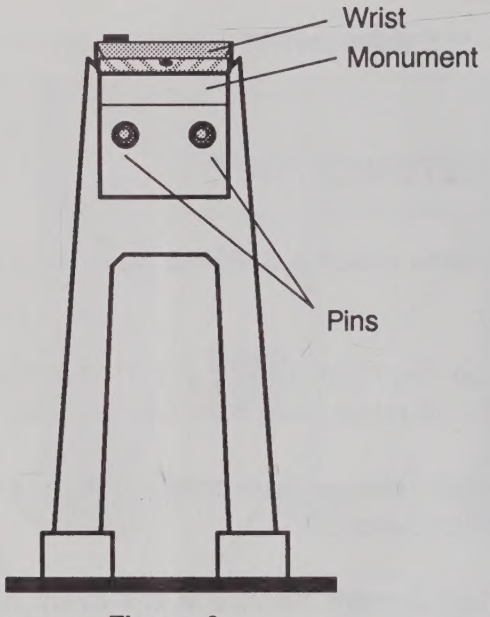

Figure 3

c. Place the monument in a hand parking station.

d. Align the Robot wrist so that the wrist pins are just about to enter the two holes in the monument as shown in Figure 3.

e. Sight through the monument holes and verify that the pins align with the holes.

CORRECTIVE ACTION **The wrist zero can be adjusted by turning the body of its position feedback potentiometer.**

Refer to Figure 4 below.

1. **Loosen the two pot adjusting screws.**

2. **Turn the pot body until the wrist zero is correct.**

3. **Retighten the two screws.**

Refer to Zymark Service Procedure R34 for additional information if necessary.

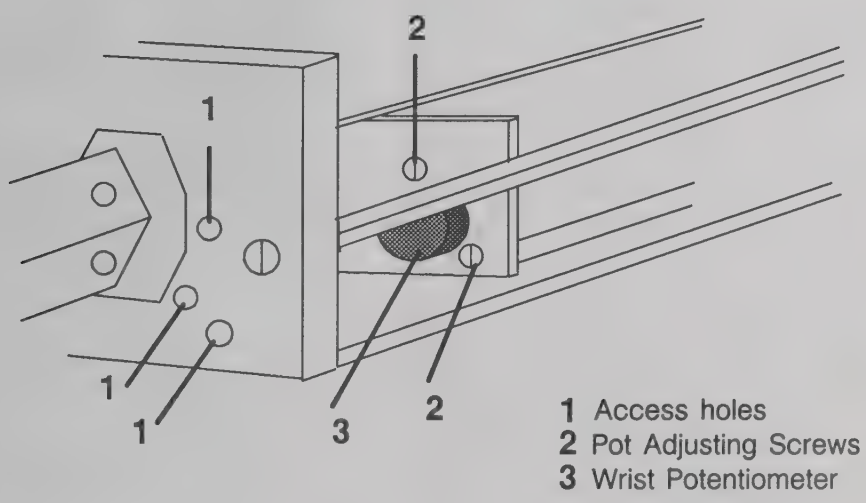

Figure 4

F. ROTARY AXIS

1. SELF-RESTORING PLAY

a. Run a program to attach a hand and fully extend the arm.

b. Position the hand near a stationary object so that small relative rotary position changes can be observed (e.g. use a piece of tape with a pencil mark on it).

c. Gently push the arm out of position, first to one side, then the other, by hand.

_____d. Verify that the arm returns to the same position within 1–2 mm.

CORRECTIVE ACTION

1. **The Robot skirt covers need to be removed for making this adjustment.**

2. **Check the tightness of the rotary drive drum set-screws. The rotary drive drum is the drum that holds the thicker set of cables wrapped around the turntable.**

3. **Insure that the Zymate I Robot is securely mounted to the table. If necessary, attach the Robot to the table using three #10 sheet metal screws (Zymark P/N 36193).**

4. **Adjust the gain on the Zymate I Robot baseboard.** *(This is the white pot towards the right side of the board.)*

5. **If further information is required, refer to the Rotary Position Test Procedure found in the Zymate Service Manual Robot section.**

2. ROTARY SOFT KEY

a. Alternately strike the CW and CCW function keys.

_____b. Verify that it takes no more than two strikes of the key to produce perceptible rotary movement.

If the Zymate I Robot fails to move, confirm that the values on the Zymate I Robot screen are CHANGING as the keys are struck. This verifies the integrity of the soft function key switches.

CORRECTIVE ACTION **If the Robot fails the soft key test, adjusting the rotary gain pot on the baseboard may correct the problem. Remove the Zymate I Robot skirts to make this adjustment. Turning the gain adjustment too far CLOCKWISE may cause the arm to twitch when moving to position rather than decelerate smoothly. After adjusting the rotary gain, use function 7 on the Robot teaching screen to move the rotary axis through a movement of 60 degrees and watch the arm for smooth deceleration.**

II. HANDS

A. CLEANING

Clean the brass receptacles on the back of the hand with a Q-tip. Worn receptacles or brass filings indicate that either the wrist zero is off or the parking station is misaligned.

B. HAND PARKING OPERATION

1. Run a HAND PARKING exercise program using positions shown below in Figure 5 (refer to Zymate Instruction Manual – Applications for the Hand Attachment / Parking Procedure or the Hand Management documentation).

2. Observe the smoothness of the operation as the hand exits and enters the parking station.

_____3. Verify that the hand is fully attached and locked to the wrist as it exits the parking station.

CORRECTIVE ACTION **It may be necessary to readjust the positions slightly to attain smooth operation with reliable hand locking.**

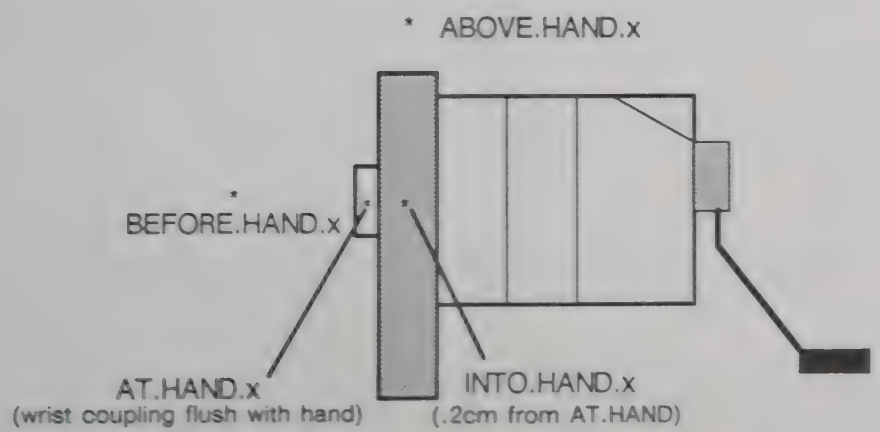

Figure 5

III. CENTRIFUGE

A. FILTER

Gently remove the filter cover. Remove the filter from the back panel and clean it by rinsing it in warm soapy water. Rinse soapy residue from filter and squeeze-dry into a paper towel.

IV. MASTER LABORATORY STATION

A. SYRINGES

1. Make sure that the six knurled knobs holding the syringe clamps in place are finger tight.

_____ 2. Run the syringes and check for chatter.

CORRECTIVE ACTION **Make sure that the speed of the syringe is not greater than 1 ml of fluid/sec. Liquids with a viscosity greater than that of water require slower speeds.**

If chattering persists, remove the syringe and dip the plunger into the solvent being used with that syringe.

_____ 3. Check for leakage.

CORRECTIVE ACTION **Refer to the Performance Check section for the Master Lab Station in the Service Manual for action to take in the event of leakage, or call Zymark Service for assistance.**

V. CONTROLLER

A. SCREEN

Clean the Controller screen with Windex or similar cleaner.

B. FILTER

Remove the filter on the side panel and clean it by washing in warm soapy water. Rinse soapy residue from filter and squeeze-dry into a paper towel.

VI. LINEAR SHAKER

A. CHECK BELT WEAR

Remove side panel and inspect the drive belt. Replace the belt if signs of wear are present. Please call Zymark if there are any questions regarding the wear of the drive belt.

PROCEDURE 2:
QUARTERLY CHECK

I. ROBOT

A. MOTOR CURRENT

The mechanical effort required to move each of the three major base axes can be determined by measuring the motor current required to drive each axis. The current is determined by measuring the voltage drop across sampling resistors. These are the three .47 ohm (yellow-violet-silver-gold) resistors located just right of center-rear on baseboard (R36, R37, R38). Remove the Robot skirts to expose the Robot baseboard. Referring to Figure 6 below, perform the following three motor measurements.

Notes:
- *Do NOT use the soft function keys to produce the motion. It will result in an incorrect diagnosis.*
- *Read the AVERAGE value, not the peak.*
- *Set the DVM on: Volts, DC, 20 V scale.*

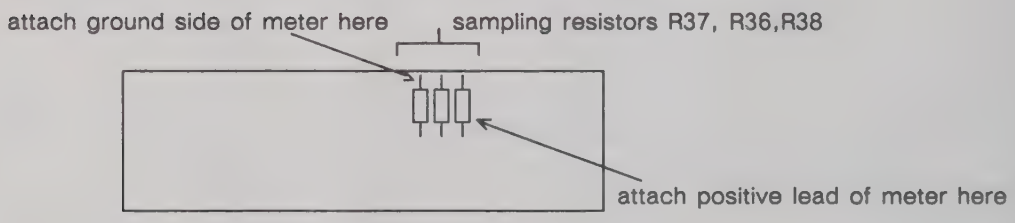

Figure 6 - Baseboard

1. ROTARY MOTOR CURRENT

a. From the Zymate I Robot teaching screen, use function 7 to produce full rotary motion (0 to 360 degrees).

b. Measure the voltage across resistor R37 (left) while the Zymate I Robot is moving CLOCKWISE.

_____c. Verify that the average voltage does not exceed .12 volts.

d. Measure the voltage across resistor R37 while the Zymate I Robot is moving COUNTER-CLOCKWISE.

_____e. Verify that the average voltage does not exceed .12 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or excessively high friction component, damaged motor gearbox, or otherwise defective motor in the rotary axis. The motor should be replaced. Refer to the Robot section of the Zymate Service Manual, procedure R14, or contact Zymark Service for assistance.**

2. VERTICAL MOTOR CURRENT

a. While on the Zymate I Robot teaching screen, use function 7 to produce full vertical motion (0 to 34 cm).

b. Measure the voltage across resistor R36 (center) while the Zymate I Robot is moving UP.

_____c. Verify that the average voltage does not exceed .24 volts.

d. Measure the voltage across resistor R36 while the Zymate I Robot is moving DOWN.

_____e. Verify that the average voltage does not exceed .06 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or excessively high friction component, damaged motor gearbox, or otherwise defective motor in the vertical axis. The motor should be replaced. Refer to the Robot section of the Zymate Service Manual, procedure R20, or contact Zymark Service for assistance.**

3. REACH MOTOR CURRENT

a. While on the Zymate I Robot teaching screen, use function 7 to produce full reach motion (0 to 32 cm).

b. Measure the voltage across resistor R38 (right) while the Zymate I Robot is moving OUT.

_____c. Verify that the average voltage does not exceed .18 volts.

d. Measure the voltage across resistor R38 while the Zymate I Robot is moving IN.

_____e. Verify that the average voltage does not exceed .14 volts.

CORRECTIVE ACTION **If reach voltage is excessive, adjust reach bearings to ensure that their tightness is not causing reach axis binding. Excessive voltage (current) indicates a binding or excessively high friction component, damaged motor gearbox, or otherwise defective motor in the horizontal axis. The motor should be replaced. Refer to the Robot section of the Zymate Service Manual, procedure R43, or contact Zymark Service for assistance.**

C. TIGHTNESS OF ARM HOUSING

1. Using a flat blade screwdriver, tighten each of the four screws that hold the arm housing together until SNUG. *DO NOT OVERTIGHTEN.*

2. If the screws moved more than 1/4 turn, readjust the reach bearings (see p. 6, section D of this document).

II. BENCHTOP

_____1. Place a level at various locations on the benchtop and verify that the benchtop is level.

_____2. Sight down the edges of the benchtop and verify that ripples or waves are not present.

CORRECTIVE ACTION

All tables will have some slight surface irregularities. Table tops will conform to the surface upon which they are sitting. Ensure that this support is flat and sturdy. Table tops should not span more than two feet without support. If a table top does not conform to the surface on which it rests, it may be necessary to clamp or bolt the table top to the support on which it sits. If you have any questions, or the top is severely warped call Zymark for assistance.

ZYMATE SYSTEM MAINTENANCE CHECK SCHEDULE

MONTHLY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SERVICE PROCEDURE
ROBOT													
Arm/Post Lubrication													
Unusual Sounds													
Cable Tension													
Reach													R92
Vertical													R91
Rotary Drive													R65
Rotary Feedback													R28
Reach Bearing Adjustment													R11
Wrist													
Self-Restoring Play													
Zero-Position													R34
Rotary Axis													
Self-Restoring Play													
Soft Key Test													
Hand													R61
Wear													
Parking													
Smoothness													
CENTRIFUGE													
Clean Filter													
MLS													
Mounting Screws													
Chatter													
Leakage													
CONTROLLER													
Clean Screen													
Clean Filter													
LINEAR SHAKER													
Check for Belt Wear													

QUARTERLY CHECK

ROBOT	JAN	APR	JULY	OCT	Service Procedure
Motor Current Measurement					
-Rotary					R14
-Vertical					R20
-Reach					R43
Arm Housing Tightness					

MAINTAINING THE ZYMATE II SYSTEM

TOOLS REQUIRED:

Screwdriver, blade, 1/8 x 4, 3/16 x 6, 1/4 x 6
Screwdriver, Phillips, #1, #2
Ball-end hex driver, 9/64
Wrench, hex (Allen), .050, 3/32, 9/64, 3/16
Wrench, open-end, 5/16
Digital Voltmeter (DVM)
Level

PREFACE:

The following preventative maintenance procedures should be used to assure that your system is functioning properly.

This procedure is organized into two sections:

1. MONTHLY MAINTENANCE AND PERFORMANCE CHECKS
2. QUARTERLY PERFORMANCE CHECKS – Includes the monthly checks

Any step having "_____" preceeding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Procedures for the replacement of parts are not provided as part of this section. Refer to the appropriate section within the Service Manual for parts replacement procedures as well as in-depth troubleshooting information.

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1:
MONTHLY MAINTENANCE AND PERFORMANCE CHECKS

***** TURN SYSTEM POWER OFF *****

I. ROBOT

A. LUBRICATION

Clean the Zymate II Robot arm and posts with a Kimwipe® that has been dampened with 10W40 motor oil. Work the affected axis back and forth while wiping the arm or post with the oil. Leave the arm and posts coated with a THIN film of oil.

B. UNUSUAL SOUNDS

While operating each axis, listen for unusual sounds which may disclose bearing dirt, rubbing or binding, squealing bearings, broken gear teeth, etc. If noises seem to be coming from the arm or post bearings repeat step A.

C. CABLE TENSION

It is good practice to establish a "feel" for normal cable tension so that abnormal conditions can be promptly detected. Periodic checking of cable tension can detect a gradual deterioration of performance at an early stage.

1. REACH CABLE

a. Position the arm at mid-height.

Note: The REACH cable is the cable that passes through the HOLE in the cable retainer in the top of the white Delrin arm housing (See Figure 2).

b. Grasp the cable (vertical section) at mid-length above the arm housing (not below) and pull it sideways.

_____c. A force of approximately 2 lbs should move the center of the cable .20 to .25 inch (.5 to .6 cm).

CORRECTIVE ACTION **The cable tension can be adjusted with a 9/64 ball-end hex driver through a hole in the bottom-left side of the column cap as viewed from the wrist-end of the arm.**

1. **Turning the screw CLOCKWISE will reduce the cable tension. Figure 1 below illustrates the direction of the clockwise adjustment.**

2. **Turning the screw COUNTER-CLOCKWISE will increase the tension.**

3. **Adjust to the description in step 1c above.**

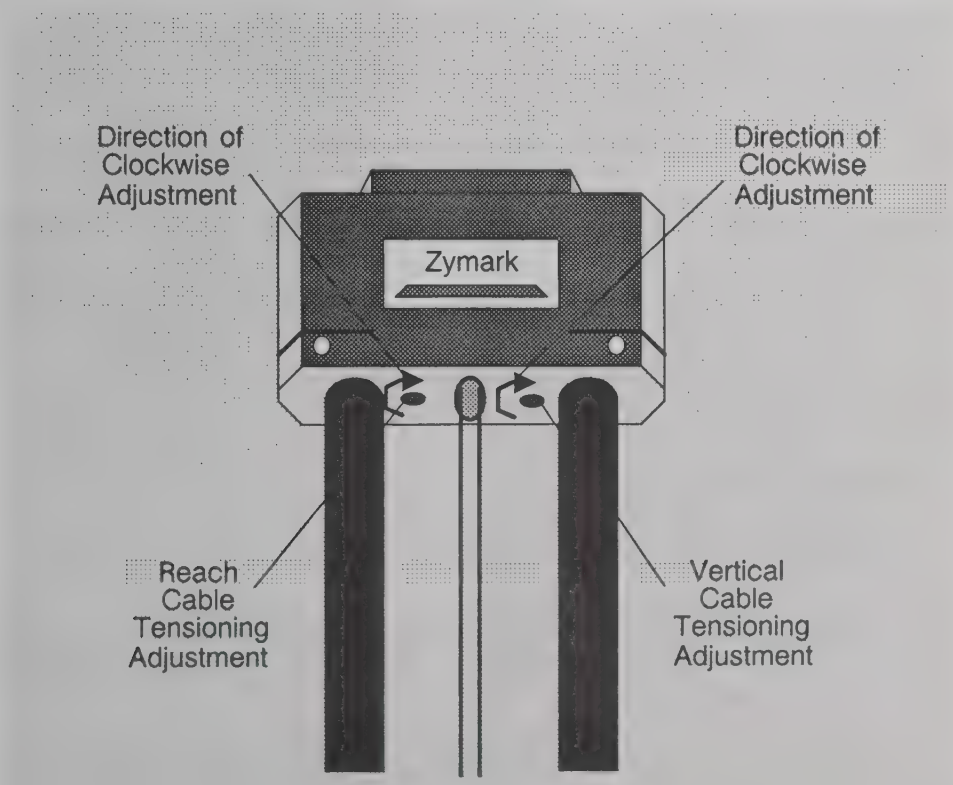

Figure 1

2. VERTICAL CABLE

a. Position the arm at mid-height.

Note: The VERTICAL cable is the one that passes through the SLOT in the cable retainer in the top of the arm housing.

b. Grasp the cable at mid-length above arm housing and pull it sideways.

___c. A force of approximately 2 lbs should move the center of the cable .20 to .25 inch (.5 to .6 cm).

CORRECTIVE ACTION **The tension on the vertical cable is higher than the reach cable because it supports the weight of the arm and arm housing. The cable tension can be adjusted with a 9/64 ball-end hex driver through a hole in the bottom-right side of the column cap as viewed from the wrist-end of the arm.**

See vertical cable adjustment reference in Figure 1, page 3.

1. **Turning the screw CLOCKWISE will reduce the cable tension.**
2. **Turning the screw COUNTER-CLOCKWISE will increase the tension.**
3. **Adjust to the description in 2c above.**

3. ROTARY DRIVE CABLE

a. Remove the Zymate II Robot skirts to gain access to this cable.

Note: The ROTARY DRIVE cable is the thicker of the 2 cables wound around the turntable. This cable is the most critical to rotary performance.

b. Grasp the LONGER of the cable sections between the turntable and the motor drive assembly and pull the cable sideways.

_____c. A force of approximately 2 lbs should move the cable .04 to .08 inch (.1 to .2 cm). This cable should feel tight.

CORRECTIVE ACTION **The adjustment of this cable appears to be simple but, if done incorrectly, the cable can be broken. Please refer to**

the Zymate Service Manual's Robot "Cable Adjustment" section, R65, if you feel an adjustment is necessary. Call Zymark with any questions you may have concerning this adjustment.

4. ROTARY SERVO CABLE

a. Remove the Zymate II Robot skirts to gain access to this cable.

Note: The ROTARY SERVO cable is the thinner of the 2 cables wound around the turntable.

b. Grasp either section of the cable between the turntable and the rotary pot assembly and pull the cable sideways.

_____c. A force of approximately 2 lbs should move the cable .15 to .20 inch (.4 to .5 cm).

CORRECTIVE ACTION **Adjustment of the rotary servo cable tension involves moving the rotary pot assembly away from, or toward, the turntable.**

1. **Loosen the two allen head screws that secure the rotary pot assembly to the baseplate just tight enough to permit the assembly to slide on the baseplate, but not enough that the assembly tips toward the turntable.**

2. **Turn the long adjustment screw that runs through the base of the rotary pot assembly to adjust the rotary servo cable tension.**

3. **After adjustment is made, retighten the two assembly mounting screws.**

4. **Check cable tension and adjust as necessary.**

D. REACH BEARINGS

The two arm (reach) bearings are adjusted with a small blade screwdriver through two holes located in the top of the arm housing, just above where the arm enters the front and rear of the arm housing (Figure 2). On Robots built after 6/88, it is necessary to first loosen the four reach bearing set screws (use the .050 Allen wrench), located just above and below the front and rear exit points of the arm. Next, turn the bearing adjustment screws COUNTER-CLOCKWISE until snug. Then, turn the adjustment screws CLOCKWISE 1/8 turn. Finally, if applicable, retighten the four reach bearing set screws.

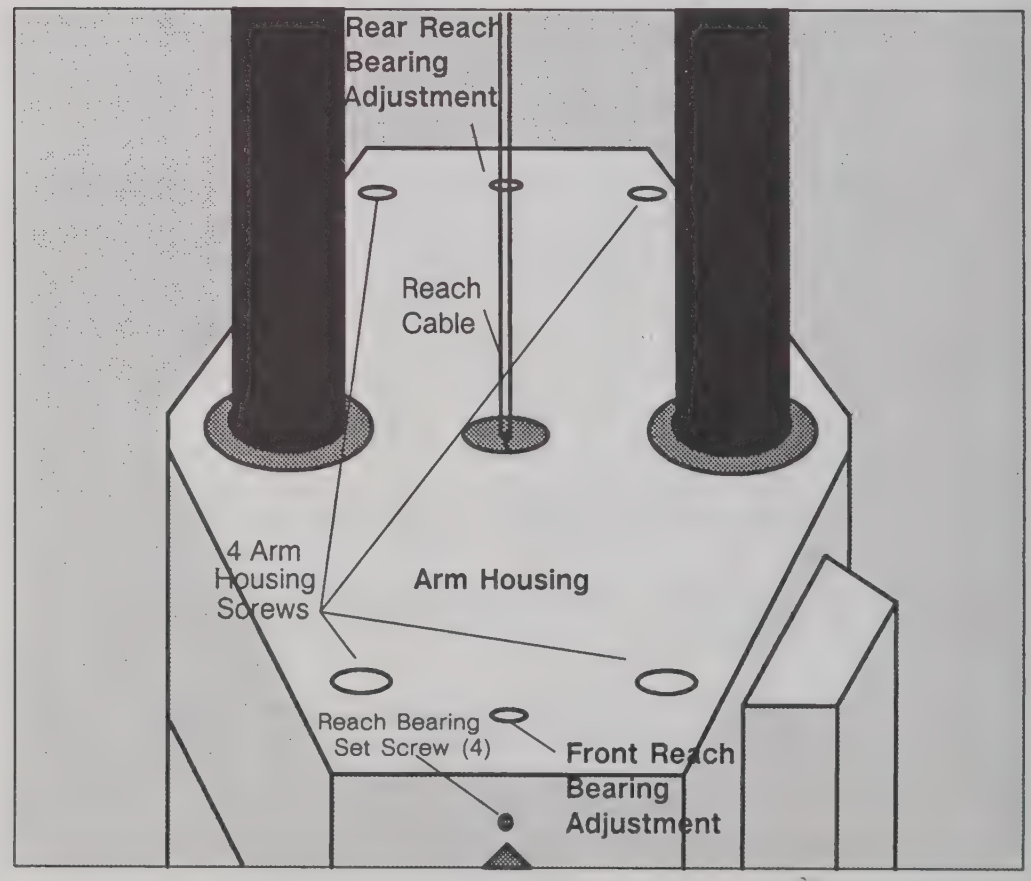

Figure 2

E. ZYMATE II ROBOT WRIST

Remove any hand attached to the wrist and check for any bent or displaced electrical pins within the wrist coupling cavity.

CORRECTIVE ACTION **Call Zymark Service for assistance.**

***** TURN SYSTEM POWER ON *****

1. WRIST SELF-RESTORING PLAY

a. Run a program to attach a SYRINGE hand (or a GP hand with a pencil in the fingers).

b. Manually rotate the hand (gently) in both directions until resistance is felt. Do not force wrist to rotate more than 1.5 degrees.

_____ c. Verify that when released from both directions, the hand returns to the same position without overshoot.

CORRECTIVE ACTION **Setting the wrist self-restoring play involves adjusting the gain pot on the wrist board.**

1. **Loosen the four screws (two on each side) on the wrist cover box.**

2. **Spread the cover slightly to slowly lift and "hinge" the wrist cover back. Use caution not to damage the ribbon cable between the wrist cover and wrist board. See Figure 3.**

3. **Adjust the gain pot at the rear of the wrist board. Turning the pot clockwise will increase the gain making the wrist more responsive.**

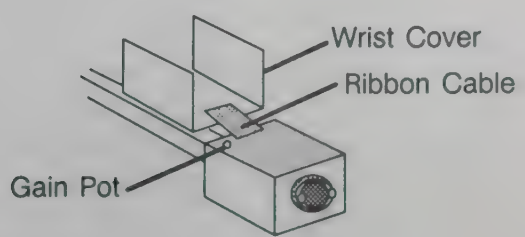

Figure 3

2. WRIST ZERO

a. Using the Zymate II Robot teaching screen, move the wrist angle to 0 degrees.

b. Remove the hand from the wrist coupling.

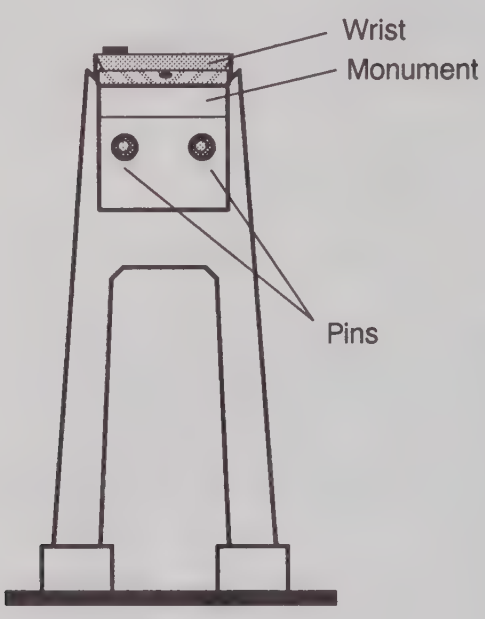

Figure 4

c. Place the monument in a hand parking station.

d. Align the Robot wrist so that the wrist pins are just about to enter the two holes in the monument as shown in Figure 4.

e. Sight through the monument holes and verify that the pins align with the holes.

CORRECTIVE ACTION **The wrist zero can be adjusted by turning the body of its position feedback potentiometer.**

Refer to Figure 5 below.

1. **Loosen the two pot adjusting screws.**

2. **Turn the pot body until the wrist zero is correct.**

3. **Retighten the two screws.**

Refer to Zymark Service Procedure R34 for additional information if necessary.

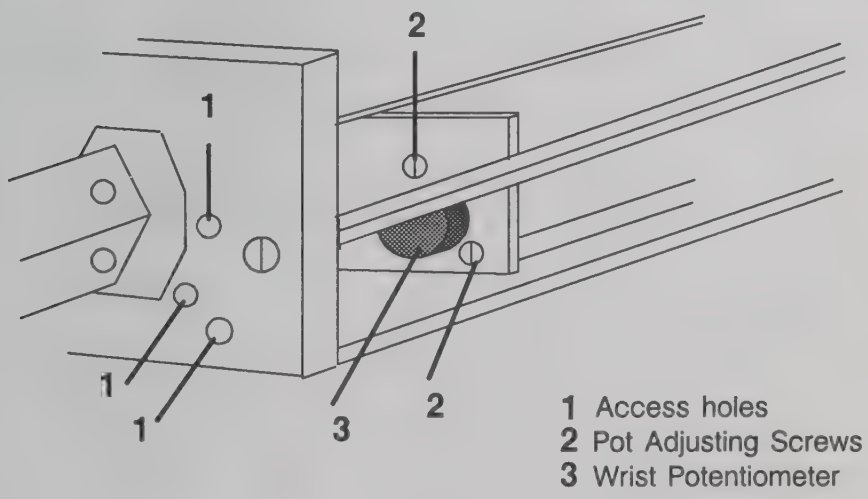

Figure 5

F. ROTARY AXIS

1. SELF-RESTORING PLAY

a. Run a program to attach a hand and fully extend the arm.

b. Position the hand near a stationary object so that small relative rotary position changes can be observed (e.g. use a piece of tape with a pencil mark on it).

c. Gently push the arm out of position, first to one side, then the other, by hand.

_____d. Verify that the arm returns to the same position within 1–2 mm.

CORRECTIVE ACTION

1. **The Robot skirt covers need to be removed for making this adjustment.**

2. **Check the tightness of the rotary drive drum set-screws. The rotary drive drum is the drum that holds the thicker set of cables wrapped around the turntable.**

3. **Insure that the Zymate II Robot is securely mounted to the table. If necessary, attach the Robot to the table using three #10 sheet metal screws (Zymark P/N 36193).**

4. **Adjust the gain on the Zymate II Robot baseboard.** *(This is the white pot towards the right side of the board.)*

5. **If further information is required, refer to the Rotary Position Test Procedure found in the Zymate Service Manual Robot section.**

2. ROTARY SOFT KEY

a. Alternately strike the CW and CCW function keys.

_____b. Verify that it takes no more than two strikes of the key to produce perceptible rotary movement.

If the Zymate II Robot fails to move, confirm that the values on the Zymate II Robot screen are CHANGING as the keys are struck. This verifies the integrity of the soft function key switches.

CORRECTIVE ACTION **If the Robot fails the soft key test, adjusting the rotary gain pot on the baseboard may correct the problem. Remove the Zymate II Robot skirts to make this adjustment. Turning the gain adjustment too far CLOCKWISE may cause the arm to twitch when moving to position rather than decelerate smoothly. After adjusting the rotary gain, use function 7 on the Robot teaching screen to move the rotary axis through a**

movement of 60 degrees and watch the arm for smooth deceleration.

3. EXCESSIVE GAIN

a. Run a program to attach a GP or Dual Function Hand.

If your procedure normally uses the Robot to move objects weighing more than a few ounces, instruct the hand to grasp the object (or one of similar weight).

b. Extend the arm to full reach to a convenient location over the benchtop.

_____c. Verify that the arm is not twitching or oscillating.

CORRECTIVE ACTION

1. **Remove the Robot's skirts.**
2. **Locate the rotary gain pot on the right side of the Robot baseboard.**
3. **Using a small screwdriver, turn the gain pot COUNTER-CLOCKWISE 1/16 turn (to reduce gain).**
4. **Replace the Robot's skirts.**

II. HANDS

A. CLEANING

Clean the brass receptacles on the back of the hand with a Q-tip. Worn receptacles or brass filings indicate that either the wrist zero is off or the parking station is misaligned.

B. HAND PARKING OPERATION

1. Run a HAND PARKING exercise program using positions shown below in Figure 6 (refer to Zymate Instruction Manual – Applications for the Hand Attachment / Parking Procedure or the Hand Management documentation).

2. Observe the smoothness of the operation as the hand exits and enters the parking station.

_____3. Verify that the hand is fully attached and locked to the wrist as it exits the parking station.

CORRECTIVE ACTION **It may be necessary to readjust the positions slightly to attain smooth operation with reliable hand locking.**

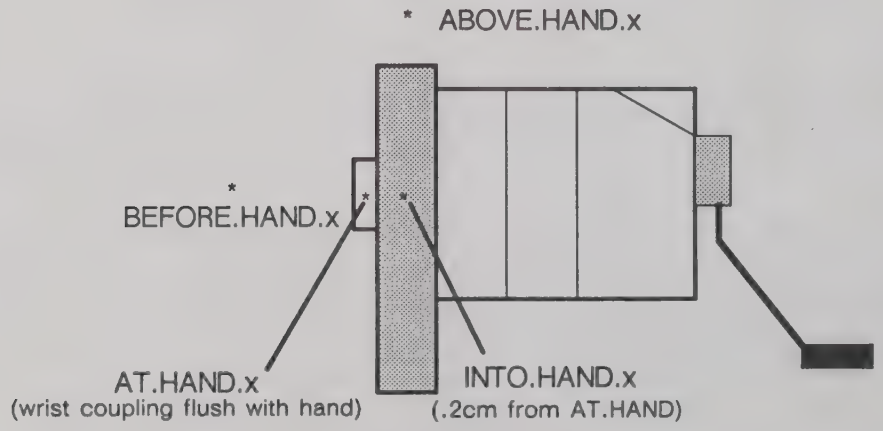

Figure 6

III. CENTRIFUGE

A. FILTER

Gently remove the filter cover. Remove the filter from the back panel and clean it by rinsing it in warm soapy water. Rinse soapy residue from filter and squeeze-dry into a paper towel.

IV. MASTER LABORATORY STATION

A. SYRINGES

1. Make sure that the six knurled knobs holding the syringe clamps in place are finger tight.

_____ 2. Run the syringes and check for chatter.

CORRECTIVE ACTION **Make sure that the speed of the syringe is not greater than 1 ml of fluid/sec. Liquids with a viscosity greater than that of water require slower speeds.**

If chattering persists, remove the syringe and dip the plunger into the solvent being used with that syringe.

_____ 3. Check for leakage.

CORRECTIVE ACTION **Refer to the Performance Check section for the Master Lab Station in the Service Manual for action to take in the event of leakage, or call Zymark Service for assistance.**

V. CONTROLLER

A. SCREEN

Clean the Controller screen with Windex or similar cleaner.

B. FILTER

Remove the filter on the side panel and clean it by washing in warm soapy water. Rinse soapy residue from filter and squeeze-dry into a paper towel.

VI. LINEAR SHAKER

A. CHECK BELT WEAR

Remove side panel and inspect the drive belt. Replace the belt if signs of wear are present. Please call Zymark if there are any questions regarding the wear of the drive belt.

PROCEDURE 2:
QUARTERLY CHECK

I. ROBOT

A. MOTOR CURRENT

The mechanical effort required to move each of the three major base axes can be determined by measuring the motor current required to drive each axis. The current is determined by measuring the voltage drop across sampling resistors. These are the three .47 ohm (yellow-violet-silver-gold) resistors located just right of center-rear on baseboard (R12, R13, R14). Remove the Robot skirts to expose the Robot baseboard. Measure each axis independently using full scale motion at speed = 0.5. Referring to Figure 7 below, perform the following three motor measurements.

Notes:

- *Do NOT use the soft function keys to produce the motion. It will result in an incorrect diagnosis.*
- *Read the AVERAGE value, not the peak.*
- *Set the DVM on: Volts, DC, 20 V scale.*

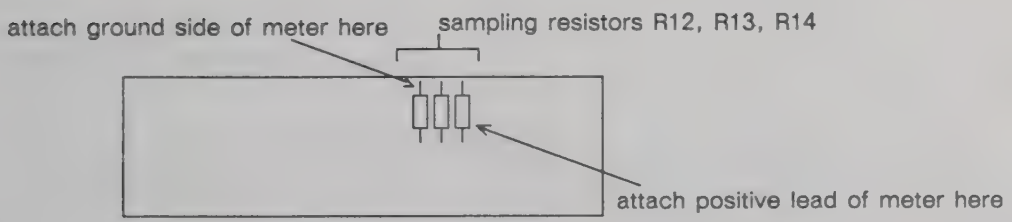

Figure 7 - Baseboard

1. ROTARY MOTOR CURRENT

a. From the Zymate II Robot teaching screen, use function 7 to produce full rotary motion (0 to 360 degrees).

b. Measure the voltage across resistor R12 (left) while the Zymate II Robot is moving CLOCKWISE.

_____c. Verify that the average voltage does not exceed .12 volts.

d. Measure the voltage across resistor R12 while the Zymate II Robot is moving COUNTER-CLOCKWISE.

_____e. Verify that the average voltage does not exceed -.12 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or excessively high friction component, damaged motor gearbox, or otherwise defective motor in the rotary axis. The motor should be replaced. Refer to the Robot section of the Zymate Service Manual, procedure R14, or contact Zymark Service for assistance.**

2. VERTICAL MOTOR CURRENT

a. While on the Zymate II Robot teaching screen, use function 7 to produce full vertical motion (0 to 34 cm).

b. Measure the voltage across resistor R13 (center) while the Zymate II Robot is moving UP.

_____c. Verify that the average voltage does not exceed .24 volts.

d. Measure the voltage across resistor R13 while the Zymate II Robot is moving DOWN.

_____e. Verify that the average voltage does not exceed -.06 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or excessively high friction component, damaged motor gearbox, or otherwise defective motor in the vertical axis. The motor should be replaced. Refer to the Robot section of the Zymate Service Manual, procedure R20, or contact Zymark Service for assistance.**

3. REACH MOTOR CURRENT

a. While on the Zymate II Robot teaching screen, use function 7 to produce full reach motion (0 to 32 cm).

b. Measure the voltage across resistor R14 (right) while the Zymate II Robot is moving OUT.

_____c. Verify that the average voltage does not exceed .18 volts.

d. Measure the voltage across resistor R14 while the Zymate II Robot is moving IN.

_____e. Verify that the average voltage does not exceed -.14 volts.

CORRECTIVE ACTION **If reach voltage is excessive, adjust reach bearings to ensure that their tightness is not causing reach axis binding. Excessive voltage (current) indicates a binding or excessively high friction component, damaged motor gearbox, or otherwise defective motor in the horizontal axis. The motor should be replaced. Refer to the Robot section of the Zymate Service Manual, procedure R43, or contact Zymark Service for assistance.**

C. TIGHTNESS OF ARM HOUSING

1. Using a flat blade screwdriver, tighten each of the four screws that hold the arm housing together until SNUG. *DO NOT OVERTIGHTEN.*

2. If the screws moved more than 1/4 turn, readjust the reach bearings (see p. 6, section D of this document).

II. BENCHTOP

_____1. Place a level at various locations on the benchtop and verify that the benchtop is level.

_____2. Sight down the edges of the benchtop and verify that ripples or waves are not present.

CORRECTIVE ACTION

All tables will have some slight surface irregularities. Table tops will conform to the surface upon which they are sitting. Ensure that this support is flat and sturdy. Table tops should not span more than two feet without support. If a table top does not conform to the surface on which it rests, it may be necessary to clamp or bolt the table top to the support on which it sits. If you have any questions, or the top is severely warped call Zymark for assistance.

ZYMATE SYSTEM MAINTENANCE CHECK SCHEDULE

MONTHLY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SERVICE PROCEDURE
ROBOT													
Arm/Post Lubrication													
Unusual Sounds													
Cable Tension													
Reach													R92
Vertical													R91
Rotary Drive													R65
Rotary Feedback													R28
Reach Bearing Adjustment													R11
Wrist													
Self-Restoring Play													
Zero-Position													R34
Rotary Axis													
Self-Restoring Play													
Soft Key Test													
Hand													R61
Wear													
Parking													
Smoothness													
CENTRIFUGE													
Clean Filter													
MLS													
Mounting Screws													
Chatter													
Leakage													
CONTROLLER													
Clean Screen													
Clean Filter													
LINEAR SHAKER													
Check for Belt Wear													

QUARTERLY CHECK

ROBOT	JAN	APR	JULY	OCT	Service Procedure
Motor Current Measurement					
–Rotary					R14
–Vertical					R20
–Reach					R43
Arm Housing Tightness					

POWER SUPPLY

P1
+13.6B
-13.6B
+5B
+VS
-VS
GND1
GND2
GND3
GND4
+13.6W
-13.6W
+8W

+13.6
-13.6
+5A
+5D
+VS
-VS

TV

ANALOG GND (SHEET 2)
DIGITAL GND (SHEET 1)
MOTOR GND (ONE PLACE SHEET 2)

WRIST GND.

WRIST

P3
+8W
-13.6W
+13.6W
GND
GND
DTCW
SYNCW
DFC

CONTROLLER

P2
DFC
DSR
DTC
RESET
+5
DTR
SYNCC
GND

2,8,10

C2 0.1 MFD +5D
U2 74HC132

C6 0.1MFD +5D
C5 5 PFD
C4 20PFD
11MHz Y1

U5 8749H 6.83 MHz
VSS VDD VCC
EA
XTAL1
XTAL2
P16
P17
TØ
PSEN
PROG
ALE
P26
P27
P10
P11
P12
P13
P14
P15
P25
P24
P23
P22
P20 (AØ)
P21 (A1)
INT
RESET
DØ–D7
RD
WR
CS

C10 100MFD 35V ALUM +5D
C9 0.1MFD

U7 8254
GND VCC
CLKØ OUTØ GATEØ (÷2^14)
CLK1 OUT1 GATE1 (÷2)
CLK2 GATE2
(ADC COUNT)

3.67 MHz
224 Hz

C11 +5D 0.1 MFD

U9 8254
CLKØ OUTØ GATE Ø
CLK 1 OUT 1 GATE 1
CLK 2 OUT 2 GATE 2

U12,Ø
U12,11
SHEET 2

ROTARY
VERTICAL
REACH

U11,1Ø
U11,11
U11,9
SHEET 2

U4 8251A
RESET
CTS
DØ–D7
TXC
RXC
RXD
DSR
DTR
RXRDY
TXD
(AØ) C/D
CS
CLK

C3 0.1 MFD +5D

U2 1/4 74HC123

U3 UA9367
DTCW

SYNCB

R48 1K
R47 1K
R1 10K
C30 470PFD
C29 470 PFD

RN4 10K (5)
RN5 10K (5)
RN2 10K (5)
RN3 10K (5)
RNI 2K (5)

U1 UA9367

R51 100Ω
R52 100Ω
U2 1/4 74HC132(3)

TC
C1 1.0 MFD

LED
LED 1 COMM ERROR
LED 2 MOTORS DISABLED
LED 3 11 MS LOOP
LED 4 SYNC

R53 27.4 K
DONE
START
A2
A1
AØ
U6,7
U6,3
U6,2
U6,1
U6,16
SHEET 2

NOTES:
1. ALL RESISTORS 1% M.F. UNLESS NOTED OTHERWISE.
2. ALL CAPACITORS 5% STACKED FILM UNLESS NOTED
3. ALL OP AMPS 1/4 TL084A

NOT USED	LAST USED
R2,R3	R54
	RN24
	U16
	C32
	D6
	Y1
	Q23
	P6

MATERIAL
FINISH
REMOVE BURRS AND SHARP EDGES
DIM. AND TOL. PER ANSI Y14.5

Dwn. M.J.K. 10-2-85
DES.
MFG.
TOLERANCES (UNLESS OTHERWISE SPEC.)
X.X = ± .030
X.XX = ± .010
X.XXX = ± .005
ANGULAR ± 1°
MACHINED SURFACES MAX UNLESS OTHERWISE SPEC.

Zymark
TITLE SCHEMATIC - ROBOT BASE
DWG. SIZE D
DWG. NO. 38727
REV 0
SCALE
SHEET 1 OF 2

+13.6
4 (6 PLACES)
084A
11
-13.6

1E
2B
3C
TO-92 TRANSISTORS
(TOP VIEW)

+5A
C16 0.1 MFD
VSS VDD
INH
VEE
cX c aX a bX b
C B A
U12
CD4053BC
-13.6
R10 10K
R11 10K
SHEET 1 { U5, 37 ROT. RCH. ENABLE
U5, 38 VERT. ENABLE
HI = OFF

C14 0.1 MFD +5A
VSS VDD
INH
VEE
bY b bX
B A C
U11
CD4053BC
SHEET 1 { U9, 10
U9, 13
U9, 17
aY a aX cY c cX

R16 221K
R17 1.0 M
C17 1.0 MFD
C18 0.1 MFD
RN15 10 K DIP
R15 3.92 K
D1 D2 IN914 (2)
C20 0.1 MFD
U13

R24 10 M CC
2N4400
R21 (2) 68.1K
Q7 Q8
R25 20K ROTARY
R20 10K
R22 10K
R23 10K
U13

RN17 4.7K
RN16
Q4 2N 5401
Q5 2N 5551
Q6 2N 5401
C19 .0033MFD
RN17 4.7K (3)
Q1 IRF 9530
Q2 IRF 520
Q3 2N 4400
R18 1.5Ω 1W WW
R19 1.5Ω 1W WW
+VS
-VS

R54 22 M
-13.6
R30 2.2 M CF
R31 221K
R32 47.5K
Q15 2N 4400
U14

R26 221K
R27 1.0M
C21 1.0 MFD
C22 0.1 MFD
RN18 10K DIP
R33 3.92K
D3 D4 IN914 (2)
U14 U15

RN21 10K DIP
C24 0.1MFD
C27 0.1 MFD
TP
TD

RN20 4.7K
RN19
Q12 2N 5401
Q13 2N 5551
Q14 2N 5401
C23 .0033MFD
RN20 4.7K (3)
Q9 IRF 9530
Q10 IRF 520
Q11 2N 4400
R28 .82Ω 1W WW
R29 1.5Ω 1W WW
R20 4.7K

R45 10K
R44 221K
R50 68.1K
R46 221K
C32 1.0MFD
U16

R37 221K
R38 1.0M
C26 1.0 MFD
C28 0.1 MFD
RN24 10K DIP
R36 3.92K
D5 D6 IN914 (2)
TE

C31 0.1MFD
R49 1.0M
R39 2.2M CF
2N4400 (2)
R40 10K
R41 47.5K
R42 12.1K
R43 681Ω
Q23
Q22

RN23 4.7K
RN22
Q19 2N 5401
Q20 2N 5551
Q21 2N 5401
C25 .0033MFD
RN23 4.7K (3)
Q16 IRF 9530
Q17 IRF 520
Q18 2N 4400
R34 1.0Ω 1W WW
R35 1.0Ω 1W WW

P6 ROT
P5
P4
VERT
REACH
MOTOR GROUND
R12 .47Ω 2W WW
R13 .47Ω 2W WW
R14 .47Ω 2W WW

U6
15 CH 1 ROT. ER.
13 CH 2
12 CH 3
11
10
9
SHEET 1 { U7, 16 COMP. OUT
U5, 30 RAMP START
U5, 29 A2
U5, 28 A1
U5, 27 AØ
VDD
I REF
VSS
V REF
RAMP CAP
MCI4447
R4 110K
C7 .01 MFD
R5 10K
R6 10K
C8 .01 MFD

RN7 27K
RN8 82K
RN9 120K
R8 10K
RN6 10K
VERT. ERROR
R9 39.2K
REACH ERROR
R7 39.2K
1614 COUNTS/VOLTS
1.241V = ZERO INPUT

RN11 27K
RN12 82K
RN13 330K
RN14 10K
RN10 10K
C12 0.1MFD
C15 0.1MFD
C13 0.1MFD
U10

CH 4 ROTARY CURRENT
CH 5 VERTICAL CURRENT
CH 6 REACH CURRENT

MATERIAL	DWN. M.J.K. 11-1-85	Zymark	
FINISH	DES.	TITLE	SCHEMATIC ROBOT BASE
REMOVE BURRS AND SHARP EDGES	MFG.	DWG. SIZE D	DWG. NO. 38727 REV 0
DIM. AND TOL. PER ANSI Y14.5	TOLERANCES (UNLESS OTHERWISE SPEC.) X.X ± .030, X.XX ± .010, X.XXX ± .005, ANGULAR ± 1°	SCALE	SHEET 2 OF 2
	MACHINED SURFACES 125 MAX UNLESS OTHERWISE SPEC.		

Zymark

ZYMATE SYSTEM
SERVICE MANUAL

VOLUME 1

ZYMATE SYSTEM SERVICE MANUAL is published by Zymark Corporation, Zymark Center, Hopkinton, MA 01748.

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Zymark Corporation

P/N 41906

ABOUT THIS MANUAL

Manual Overview

The Zymark Service Manual is designed to give the Zymate I, Zymate II and PySystem user the capabilities to maintain, troubleshoot and repair most major system modules. These presently include the Robot, Controller, Master Lab Station, Power and Event Controller, the Printer, the Z850 Balance Interface and the Z840 Computer Interface.

Most procedures can be successfully performed by someone with a minimal understanding of electronics and mechanics. A small number of procedures are difficult enough to be recommended only for those who have attended Zymark's Service School.

Manual Layout

This two-volume manual contains the following sections:

- The Zymate System section includes checks, adjustments, specifications and maintenance charts for major Zymate System modules.
- The Controller section provides performance, replacement and adjustment documentation for the the Zymate I Controller. Information provided for module boards and software updates is also applicable to the Zymate II Controller.
- The Robot section provides detailed information on the Zymate I and II Robot. Because of the mechanical and electrical complexity of the Robot, you will find this section of the manual contains the greatest amount of documentation.
- The next section contains similar documentation for servicing the Master Lab Station.
- The first section in Volume 2 describes performance and service procedures for the Power and Event Controller.
- Following the Power and Event section is a similar section containing Printer performance checks.
- The next two sections contain information on the Z850 Balance Interface and the Z840 Computer Interface.
- The last section the manual contains schematics of all Zymark pc boards in a separate, detachable binder.

Sectional Layout

The outline below describes the sub-section contents typical to most sections in the manual.

- The Table of Contents categorizes and lists all sub-sections in the order that they appear.
- The Index alphabetically lists subassemblies, components, problems and procedural methods for Zymate modules and cross references them to

procedures within the section. Use the Index when you need to find a specific procedure (or page within a procedure) to perform a task or extract information concerning some aspect of a Zymate module.

- The Theory of Operation gives an overview of Zymate modules from an operational, mechanical and electrical standpoint.

- The Performance Check sub-section allows you to verify that a module meets current Zymark operational standards and gives you corrective action steps to take should those standards not be met. Use the Performance Check section after performing repair, replacement or adjustment procedures.

- The Repair/Replacement sub-section contains procedures detailing the steps necessary to repair and/or replace sub-assemblies and components within a module. Each procedure is designated by a randomly chosen letter/number combination that allows for easy insertion of new procedures as additional documentation is released. Presently, Controller procedures are designated with the letter C, Robot procedures with the letter R, Master Lab procedures with the letter M and Power and Event procedures with the letter P.

Special Information

In addition to the above sub-sections, this manual contains the following information.

- Hand information for General Purpose and Syringe Hands is contained as part of the Robot I/II Performance Check.

- Troubleshooting information for Zymate I and II Robots can be found in the Zymate I and Zymate II Robot Initialization Troubleshooting Guides in the Robot section of the Manual. The majority of electronic failure associated with the Robot can be identified through use of these guides.

- The Rotary Test procedure in the Robot section provides the means to test rotary position accuracy, and troubleshoot and correct problems affecting the Robot's rotary axis.

- The PyRobot Calibration procedure contains information to determine if your PyRobot requires re-calibration, and if so, provides the necessary steps for recalibrating. If you have a Pytechnology System, use this procedure after performing replacement/repair/adjustment procedures that affect Robot positioning.*

- The Robot section also contains a group of detailed exploded views and technical illustrations that are useful when performing replacement or repair procedures. Many of these illustrations are used in reduced form throughout the Robot section.

- The Master Lab Station Troubleshooting Guide deals with identifying and solving initialization, syringe and valve problems.

**Procedures that affect Robot positioning have notes referring the PyRobot user to the PyRobot Calibration Procedure.*

McBEE

Zymate System

Section 1: Maintenance, Zymate I

Maintaining the Zymate I System

Section 2: Maintenance, Zymate II

Maintaining the Zymate II System

Zymate I Controller

Section 1: Performance

Zymate I Controller Performance Check

Section 2: Repair/Replacement

C10 Zymate I CRT Monitor Replacement Procedure
C18 Zymate I PCB Replacement Procedure – Keyboard
C20 Module Board Software Update
C32 Zymate I Keyboard Unit Replacement Procedure
C37 Battery Replacement Procedure
C41 Disk Drive Replacement for Zymate I Controllers
C56 Todd Power Supply Retrofit Procedure
C58 Power Supply Adjustment Procedure (Power One power supply)
C59 Power Supply Adjustment Procedure (Todd power supply)
C60 Todd Power Supply Replacement Procedure
C68 Zymate I Controller PCB Replacement
C80 Zymate I CRT Adjustment Procedure

CONTROLLER INDEX

Description	Perform. Check pg. no.	Trouble Guide pg. no.	Proc. No.
BATTERIES			
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Replacement			C37
CRT			
Adjustment			C80
Failure to Display	5		
Poor Display Quality	5		
Replacement			C10
DISK DRIVE			
Operations Check	10		
Replacement			C41
INPUT VOLTAGE			
Selection Check	2		
Fuse Check	2		
KEYBOARD			
Operations Check	7		
Small Keypad Check	8		
Soft Key Check	7		
Replacement			C32
PC Board Replacement			C18

Description	Perform. Check pg. no.	Trouble Guide pg. no.	Proc. No.
MODULE BOARDS			
Software Update			C20
PC BOARD			
CPU Board:			
Battery Replacement			C37
CRT Display	5		
Clock Failures	7		
Replacement			C68
Keyboard			
Check	7		
Replacement			C18
Memory Expansion			
Replacement			C18
Module Support			
Jumper Configuration	4		
PERFORMANCE			
Initial Power Check	2		
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Controller Operation	5		
Keyboard Operation	7		
Floppy Disk Drive Operation	11		
CPU Operation	11		

Description	Perform. Check pg. no.	Trouble Guide pg. no.	Proc. No.
POWER SUPPLY			
Voltage Check 2			
Voltage Adjustment.			C58 C60
Replacement			C58 C60
Retrofit			
Todd Power Supply			C56
SOFT KEYS			
Operations Check 7			

ZYMATE I CONTROLLER
PERFORMANCE CHECK

PROCEDURE SCOPE:

The following performance check may be used to verify that the module IS or IS NOT functioning properly. This performance check verifies:

1. Proper System Configuration
2. CRT Alignment
3. Keyboard and Soft Key Operation
4. Floppy Disk drive Operation
5. CPU Operation

TOOLS REQUIRED:

Screwdriver, blade, 1/8
Screwdriver, Phillips, #1
Floppy Disk, blank
Digital Voltmeter (DVM)

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Procedures for the replacement of parts are provided as well as in-depth troubleshooting information in this chapter of the Zymark Service Manual.

PROCEDURE 1: INITIAL CHECK

> **CAUTION:** **BEFORE PERFORMING THE CONTROLLER PERFORMANCE CHECK, SAVE THE CURRENT SYSTEM DICTIONARY ON A FLOPPY DISK. THIS WILL ENSURE THAT PREVIOUSLY CREATED MODULE COMMANDS AND PROGRAMS WILL NOT BE INADVERTENTLY LOST.**

A. INPUT VOLTAGE SELECTION

1. Turn the Zymate System's power OFF.
2. Remove the power cord from the rear of the Controller.

_____3. Verify that the input card located inside the power connector is selecting the proper voltage (120 VAC or 240 VAC).

CORRECTIVE ACTION **Turn the card so that the proper voltage is selected.**

4. Remove the fuse.
5. Compare its value with the value indicated on the serial number tag above the power connector.

   a. 120 VAC – 5 amp fuse

   b. 240 VAC – 3 amp fuse

6. Reinstall the power cord.

B. POWER SUPPLY VOLTAGES

- *The power supply voltages can be checked at terminals located inside the top cover on the left side of the Controller.*
- *The labels for the terminals appear on the top of the power supply.*

1. Using a Phillips screwdriver, remove the four screws securing the top cover of the Controller.
2. Remove the cover and set aside.
3. Using a blade screwdriver, remove the four 6/32 screws securing the sheet metal monitor cover.
4. Remove the monitor cover and set aside.
5. Set the DVM to: Volts, DC, 20V scale.

6. Turn the Zymate System's power ON.
7. Check the +5V supply. (This supplies power to all logic boards):
   a. Touch the DVM voltage lead to the +S terminal.
   b. Touch the common lead of the DVM to the –S terminal.
_____ c. Verify that a voltage reading of +5.00 volts is obtained.
8. Check the +12V supply:
   a. Touch the DVM voltage lead to the +12V terminal.
   b. Touch the common lead of the DVM to the 12V RTN terminal.
_____ c. Verify that a voltage reading of +12.00 volts is obtained.
9. Check the –12V supply:
   a. Touch the DVM voltage lead to the –12V terminal.
   b. Touch the common lead of the DVM to the 12V RTN terminal.
_____ c. Verify that a voltage reading of –12.00 volts is obtained.
10. Check the optional voltage. (Supply for CRT board):
   a. Touch the DVM voltage lead to the OPT V+ terminal.
   b. Touch the common lead of the DVM to the OPT V– terminal.
_____ c. Verify that a voltage reading of +12.00 volts is obtained.

CORRECTIVE ACTION

Refer toC58 (Power One Power Supply) or C59 (Todd Power Supply) for detailed instructions for making power supply adjustments.

If these voltages cannot be adjusted to the value indicated, replace the power supply. Refer to C56 or C60 for power supply replacement procedures.

PROCEDURE 2: SYSTEM CONFIGURATION

1. Using a blade screwdriver, turn the front panel fasteners 1/2 turn COUNTER-CLOCKWISE to unlock. (CLICK willl be heard.)
2. Remove the Controller's front panel.
3. Verify that at least three board are installed in the card cage.

STANDARD BOARD CONFIGURATION:

CPU Board - 2nd slot of card cage from top

Memory Expansion Board - immediately below CPU board

Module Support Board - bottommost slot of card cage

The order of the boards in the card cage is not important. However, the TOP slot of the card cage must remain empty.

4. Remove the Module Support board.

   The Module Support board has the metal pan in front of it and connectors located approximately two thirds of the way back for the module cards.

   a. Grasp the inside edges of the two nylon board removers.

   b. Pull forward and outward on these removers.

   c. Slide the board straight out from the Controller.

_____5. Verify that the Module Support board has three jumpers in locations E1, E2, and E3.

6. If more than one Module Support board is required, it may be located anywhere in the card cage with the exception of the topmost slot.

_____7. Verify that this Module Support board has 1 of its jumpers offset.

(It is not important as to which of the three jumpers is offset.)

When a jumper is "offset", it is placed on one pin, leaving the other pin open. A jumper that is NOT offset connects across both pins.

_____8. Verify that the module cards for all modules used in the system are installed and properly connected.

PROCEDURE 3: CONTROLLER OPERATION

A. POWER ON CHECK

1. Before powering the Controller, depress the second and fourth soft keys located on the face of the Controller. (COLD START).
2. While holding these keys in, turn the Controller's power ON.
3. Release the keys.

_____4. Verify that the fans located on the right side of the card cage are operating.

CORRECTIVE ACTION

If the Controller does not power up, check the AC power source.

If the AC power source is OK, check that the correct power input has been selected and that the fuse is OK. (Refer to Procedure 1: INITIAL CHECK)

Check the power supply voltages (Refer to Procedure 1)

_____5. Verify that the Master Menu is displayed on the CRT after a short warm up.

CORRECTIVE ACTION

If the SYSTEM MANAGEMENT screen is displayed, the battery (batteries) on either the CPU or Memory Expansion board need to be replaced. (This will occur V1.3 or later software only. V1.3 software was released in April 1984.) Refer to C37 BATTERY REPLACEMENT for detailed instruction in this procedure.

B. QUALITY OF SCREEN

1. Display the Edit Program screen.
2. Verify screen display quality:
   a. All portions of the screen are in focus.
   b. All characters are the same size.
   c. All lines are parallel with the Controller.
   d. The display is stable.

CORRECTIVE ACTION

Refer to C80 CRT ADJUSTMENT PROCEDURE for detailed instruction in aligning the display.

If a rolling picture continues to occur AFTER adjustment has been made, the CPU board may be defective. Refer to C68 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction in replacing the CPU board.

If the quality of the CRT cannot be adjusted satisfactorily, the monitor or its control board may be defective. Refer to C10 CRT MONITOR REPLACEMENT for detailed instruction in replacing the monitor and its board.

3. Display other screens.

_____4. Verify that none of the following occurs:

   a. Broken characters

   b. Unstable display that cannot be adjusted.

   c. Partial screen displayed.

CORRECTIVE ACTION

The CPU board may be defective. Refer to C68 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction in replacing the CPU board.

PROCEDURE 4: KEYBOARD OPERATION

A. KEYBOARD CHECK

1. Display the Direct Control screen.
2. Press each key on the keyboard.
3. Verify that the correct character is displayed on the screen at that time.
4. As the cursor approaches the right hand side of the screen, press the RETURN key.
5. Ignore the displayed error message and continue until all keys have been tested.

CORRECTIVE ACTION

If 1 or 2 keys fail to operate, the keyboard is defective. Refer to either C18 or C32 for detailed instruction on replacing either the pc board in the keyboard or the entire keyboard unit.

If several keys fail to function, perform the SOFT KEY TEST that follows.

If several keys are functional, replace either the pc board in the keyboard, or the entire keyboard unit.

a. **If ALL soft keys are functional, replace either the pc board in the keyboard, or the entire keyboard unit.**

b. **If any of the soft keys fail, refer to C68 PRINTED CIRCUIT BOARD REPLACEMENT for instruction on replacing the CPU board.**

B. SOFT KEY CHECK

1. If a Robot is installed, display its teaching screen.
2. If no Robot is installed, display the Edit Program screen.
3. Press each soft key.
4. Verify that the appropriate response occurred when the key was pressed.
5. If a key fails, verify lack of response on another screen (as a double check).

CORRECTIVE ACTION

If a soft key fails to produce a response and some of the keys on the keyboard also fail, the CPU board is defective. Refer to C68 PRINTED CIRCUIT BOARD REPLACEMENT for instruction on replacing the CPU board.

If one soft key consistently fails, replace the soft key.

If one soft key fails intermittently and all keys on the keyboard are functional, replace the soft key.

C. SMALL KEYPAD CHECK

1. Create a program to check the operation of the small keypad.

   a. Go to the Edit Program screen.

   b. Write the Keypad Test program as follows:

      EasyLab Program Name: KEY.TEST

```
   A=0
10 A=A+1
   PRINT A
   GOTO 10
```

2. Go to the Direct Control screen.
3. Run the KEY.TEST program.
4. While the program is running, test the small keypad.
5. STEP key:

   a. Press the STEP key.

_____ b. Verify that the program stops.

   c. Press the STEP key again.

_____ d. Verify that the next line in the program appears and is executed.

6. CONT key:

   a. Press the CONT key

   b. Verify that the program continues from where it left off with no pauses.

7. PAUSE key:

   a. Press the PAUSE key

_____ b. Verify that the program stops.

   c. Press CONT.

8. STOP key:

   a. Press the STOP key.

_____ b. Verify that the program stops.

   c. Press CONT.

9. ABORT key:

Pressing the ABORT key while a program is running will not cause any response. The program must be stopped prior to aborting it.

a. Press the STOP key.

b. Press the ABORT key.

_____ c. Verify that the "Z" prompt appears.

10. RET key:

a. Press RET

_____ b. Verify that the Master Menu is displayed.

CORRECTIVE ACTION

If a key fails to produce the described response, the keyboard may be defective. Refer to either C18 or C32 for detailed instruction on replacing either the pc board in the keyboard or the entire keyboard unit.

PROCEDURE 5: FLOPPY DISK DRIVE OPERATION

A. READ/WRITE MECHANISM

1. Insert a disk containing a previously saved dictionary into the disk drive unit.
2. Display the Direct Control screen.
3. Type LOAD and press RETURN.

   The dictionary should load from the disk into the Controller's memory at this time.
4. When "Z" is displayed, type DIC and press RETURN.
5. Hold the STEP key down.

_____6. Verify that the dictionary contained on the disk is now displayed on the screen.

CORRECTIVE ACTION

If a dictionary fails to load properly, check to see if the memory is full or nearly so on the System Management screen.

Try loading another disk. If garbled information appears, the disk drive, CPU or Memory Expansion board may be defective.

If the disk drive unit is excessively noisy, or takes a considerable amount of time loading information, the disk drive may be defective. Refer to C41 DISK DRIVE REPLACEMENT for detailed instruction.

B. WRITE PROTECT MECHANISM

1. Remove the disk from the disk drive.
2. Place a write-protect tape over the notch in the top right corner of the disk.
3. Reinsert the disk.
4. Type SAVE and press RETURN.
5. Verify that a write-protect error message is displayed on the screen at this time.

CORRECTIVE ACTION

The disk drive unit may be defective. Refer to C41 DISK DRIVE REPLACEMENT for detailed instruction in replacing the disk drive.

PROCEDURE 6: CPU OPERATION

1. Display the Master Menu.
2. Select each of the five possible operational modes of the Controller from the Master Menu.
3. Screen 1: **RUN PROGRAM**

_____ a. Verify that a single reverse video line appears towards the bottom of the Master Menu page prompting for the program name.

b. Press RETURN to exit the RUN PROGRAM mode.

4. Screen 2: **EDIT PROGRAM**

_____ a. Verify that a listing of all programs currently in the EasyLab Program Directory appears on the screen.

b. Select a program from the directory using the appropriate function keys.

c. Display that program by pressing the EDIT function key.

_____ d. Verify that the program is correct with no random characters or garbled lines.

5. Screen 3: **BENCH & MODULE SETUP**

_____ a. Verify that all modules installed in the system are listed on the Bench & module setup screen.

CORRECTIVE ACTION

If a module is installed but not listed, try the module card in an alternate connector on the Module Support board.

If the module still does not list, refer to the Performance Check for that module in its chapter of the Zymark Instruction Manual.

b. Select each module listed on the Bench & module setup screen.

_____ c. Verify that the module's teaching screen is displayed and is functional.

6. Screen 4: **SYSTEM MANAGEMENT**

_____ a. Verify that the System Management screen is displayed.

_____ b. Verify that the battery status for both boards reads GOOD.

c. Set the Time-of-Day clock.

d. Return to the Master Menu page.

_____ e. Verify that the clock is running and it increments at the proper speed.

A clock malfunction generally causes the clock to run at twice the normal speed.

7. Screen 5: **DIRECT CONTROL**

_____ a. Verify that the Direct Control screen is displayed.

b. Type DIC and press return.

c. Hold the STEP key down.

_____ d. Verify that the system dictionary was properly displayed.

CORRECTIVE ACTION

Replace the CPU board if any of the following occurred: (1) Random characters (2) garbled lines (3) clock malfunction (4) partially displayed screen (5) screen not displayed. Refer to C68 for detailed instruction to replace the CPU board.

ZYMATE I
CRT MONITOR REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and replacement of the CRT monitor in the Zymate I Controller.

PARTS REQUIRED:

CRT Monitor, P/N 36198 (with circuit board)

TOOLS REQUIRED:

Screwdriver, blade, 3/16, 1/4
Screwdriver, Phillips. #1
Needle nose pliers
Test lead w/ alligator clips on both ends

> CAUTION: **Before performing this Controller service procedure, SAVE the system dictionary on a floppy disk. This will ensure that previously created module commands and programs will not be inadvertently lost.**

PROCEDURE 1: DISASSEMBLY MONITOR

A. ACCESS THE MONITOR

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Disconnect the power cord from the rear of the Controller.
4. Using a Phillips screwdriver, remove the four screws securing the top cover of the Controller.
5. Remove the cover.
6. Using a blade screwdriver, remove the four 6/32 screws securing the sheet metal monitor cover.
7. Remove the eight plastic function key covers on the front of the screen.
8. Remove the plexiglass window.

WARNING

1. **HIGH VOLTAGE!**

   High voltage may be present on the CRT anode (13 kV) even when the monitor is not operating. The flyback transformer (T101) generates high voltages during monitor operation. Any conductive material which is placed close to the transformer case can cause an arc to jump the gap between the case and conductive material. This occurs when the air gap ionizes and becomes a conductive path.

2. **CRT**
   - **Handle the CRT with care. Since the CRT contains high vacuum, breakage may cause injury from flying glass.**
   - **Do not hit or scratch the CRT.**
   - **Do not subject the CRT or more than moderate pressure.**
   - **Do not hold the CRT by its neck since pressure on the neck base may cause CRT breakage.**

B. REMOVE MONITOR

1. Discharge the CRT high voltage anode before servicing the monitor.
   a. Attach one end of the clip lead to the grounding spring.
   b. Attach other end of the clip lead to the center portion of the screwdriver.
   c. Grasp the screwdriver handle well away from the screwdriver shaft.

> ***WARNING***
>
> **Use one hand only. Throughout discharge procedure, do not touch anything with your free hand.**

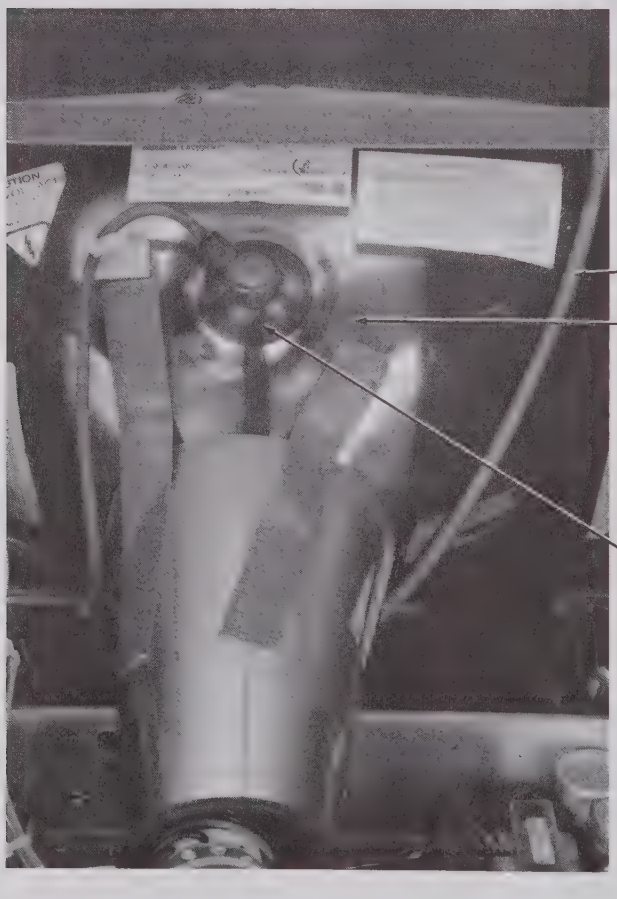
d. Slip the screwdriver blade between the anode cap and the CRT.

Anode cap may tend to stick making it necessary to gently pry up edge of cap.

e. Carefully push the screwdriver blade to the center of anode cap and touch the blade to the metal anode.

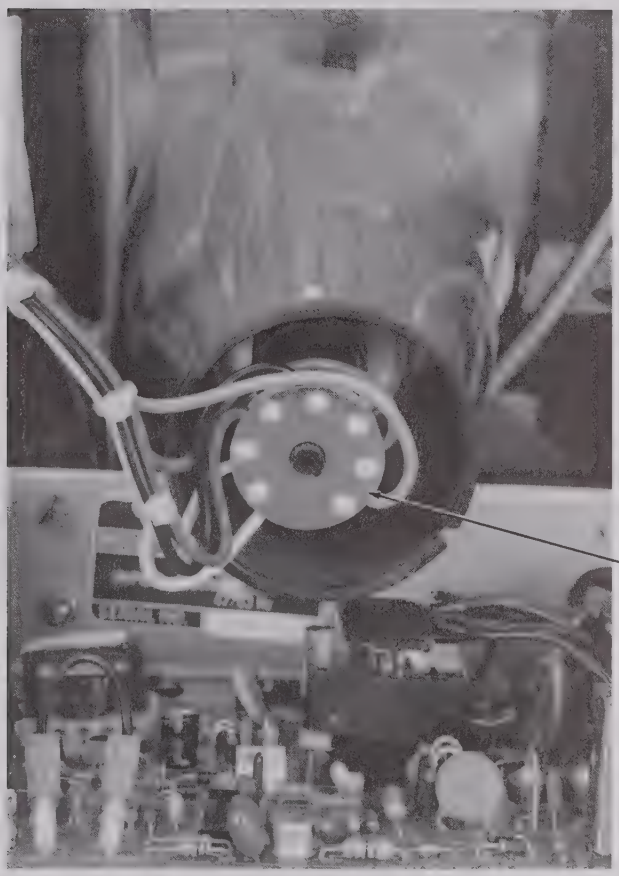
A noticeable spark will generally result.

f. Maintain this contact for minimum of five seconds.



1. Anode cap
2. CRT monitor
3. Grounding spring

2. Remove the anode cap by firmly grasping the clear cover and moving it to one side while twisting the other side of the clip out.
3. Unplug the CRT connector (note that it is keyed) from the extreme end of the CRT with a gentle rocking motion.



1. CRT connector

4. Remove the yoke signal cable from the monitor circuit board.

Connector is keyed between red and blue wires.

1. Monitor circuit board
2. Connector (J104)
3. Yoke signal cable (J105)
4. Connector (J106)
5. Connector (J103)
6. Ground cable
7. Horizontal size coil

5. Using a blade screwdriver, remove the four CRT mounting screws.

1. CRT mounting screw (4)

6. CAREFULLY remove the CRT from the Controller.

PROCEDURE 2: DISASSEMBLY – CIRCUIT BOARD

If the board is being removed only – discharge the anode (pages 3 & 4).

A. UNPLUG CONNECTORS

1. Remove the two green ground cables from J105 (top front) of board.
2. Remove the connector from J106 (top center) of board.

   ORDER: Black, , , , Black, White , Red, Green, Black
3. Remove the orange and green connector from J104. (Just above fuse.)
4. Remove the connector from J102. (Just below fuse.)

   ORDER: Red, Blue, Yellow, Brown

1. Monitor circuit board
2. Connector (J104)
3. Yoke signal cable (J105)
4. Connector (J106)
5. Connector (J103)
6. Ground cable
7. Horizontal size coil

B. REMOVE BOARD

1. Using needlenose pliers, carefully release the five white nylon board standoffs.
2. Push them through the sheet metal housing.

PROCEDURE 3: CIRCUIT BOARD INSTALLATION

1. Ensure that the five nylon standoffs have been attached to the circuit board.

   Fat side of standoffs on circuit side of board.

2. Install the board so that the edge connector is at top center.

1. Nylon board standoff
2. Monitor circuit board

PROCEDURE 4: MONITOR INSTALLATION

A. INSTALL CRT

1. Insert the CRT into the opening using care so that the grounding spring goes under the tube shield.
2. Replace the four mounting screws.
3. Tighten the screws.
4. Install the CRT plug at the rear of the CRT.
5. Install the yoke cable to J102.
6. Install the anode cap into its socket.
    a. Secure the cable to its holder.

B. REATTACH CONNECTORS

1. Install the connector (red, blue, yellow, brown) to J102. (Just below fuse.)
2. Install the connector (orange and green) to J104. (Just above fuse.)
3. Install the large connector to J106. (Top center of board.)
4. Connect the two green ground cable to J105. (Top front of board.)

C. FINALLY

1. Replace the plexiglass window.
2. Replace the eight plastic function keys.
3. Install the sheet metal monitor cover.
4. Replace the top cover using care to align the plexiglass window into the top channel of the cover.
5. Secure the top cover with the screws.

ZYMATE I
PRINTED CIRCUIT BOARD REPLACEMENT PROCEDURE – KEYBOARD

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the printed circuit board in the Zymate I Controller's keyboard.

PARTS REQUIRED:

PC Board, P/N 36314

TOOLS REQUIRED:

Screwdriver, Phillips, #1
Screwdriver, blade, 1/8"

PROCEDURE 1: DISASSEMBLY

A. ACCESS PC BOARD

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Locate the two screws, one on either side of the keyboard unit.
4. Using the Phillips screwdriver, remove these two screws.

B. REMOVE KEYBOARD FROM HOUSING

1. Using a small blade screwdriver, gently pry the keyboard from its housing.

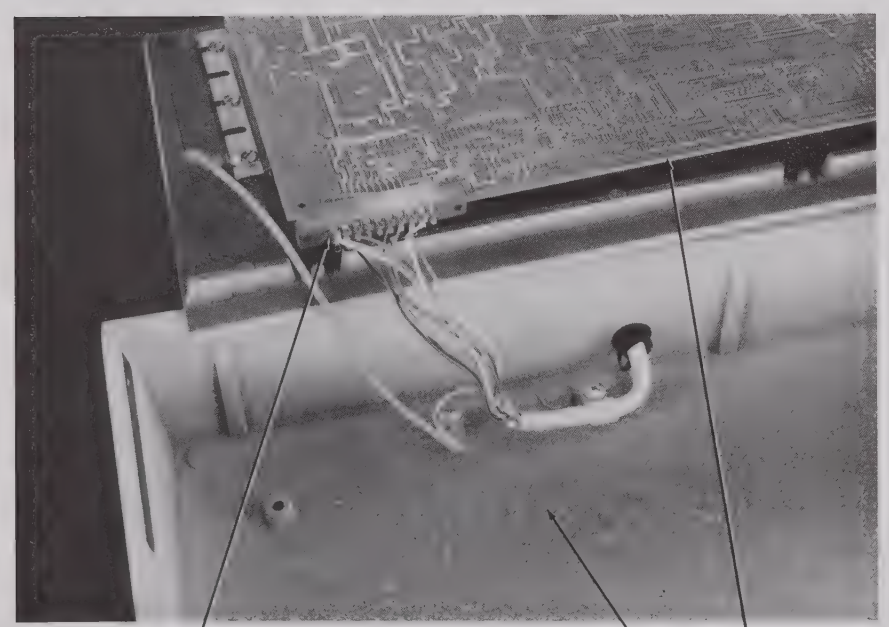
   Pry at the rear of the keyboard

2. Remove the keyboard from its housing.

   Do not disconnect the keyboard.

3. Place the keyboard aside, gently laying it on its keys.

CAUTION: Do not disturb any wires or the connector that attaches the PC board to its housing.



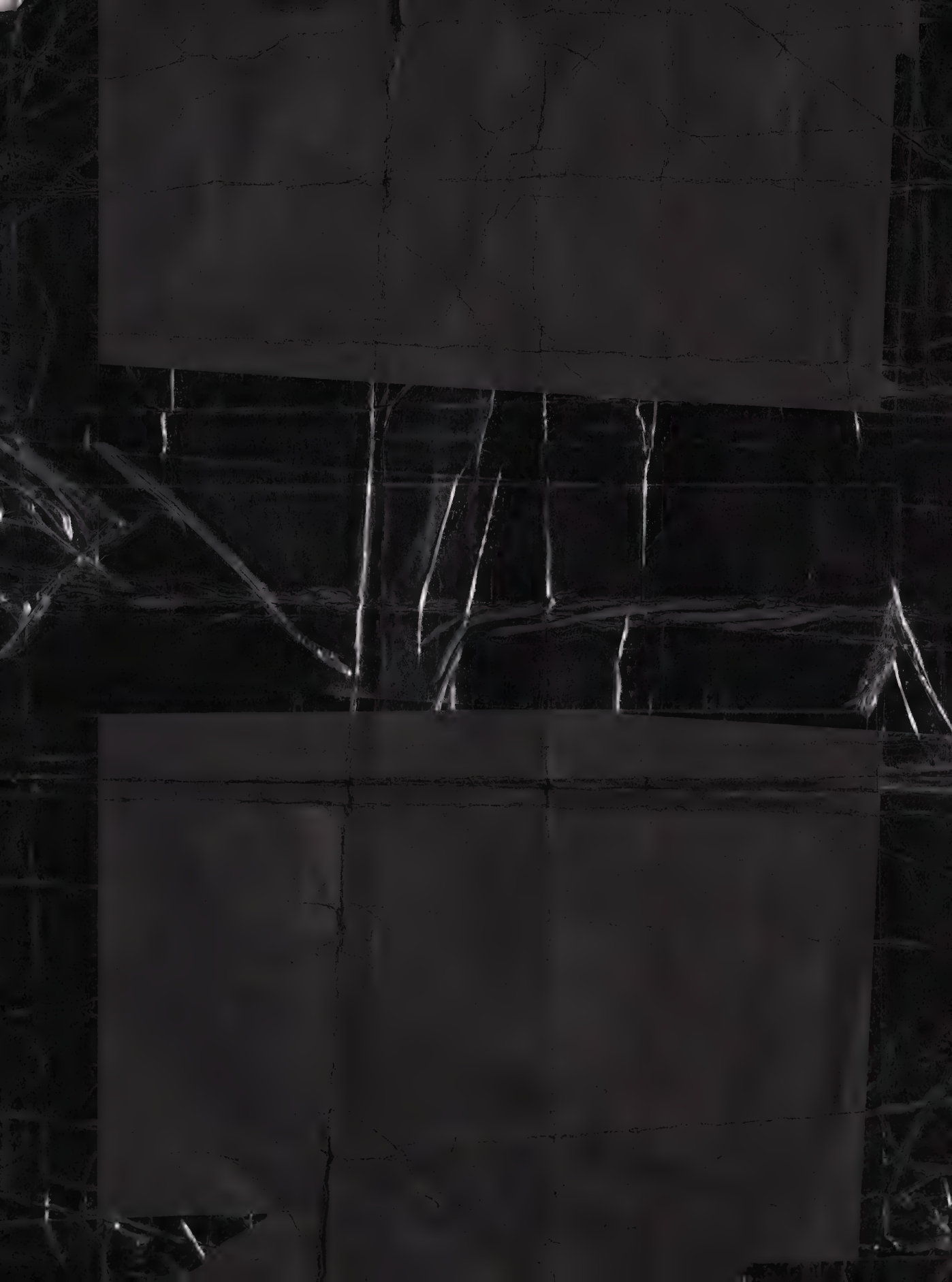
1. Connector
2. Keyboard housing
3. PC board

C. DISCONNECT PC BOARD FROM HOUSING

1. Locate the 20 pin connector.
2. Observe the positioning of the connector in relation to the board.

   This connector should have a locating key between the third and fourth pins from the left end of the connector. If not keyed, pin A of connector is matched to pin 1 of board.

3. Disengage the connector from the circuit board.



PROCEDURE 2: INSTALLATION

A. CONNECT THE NEW KEYBOARD

1. Plug in the 20 pin connector

   Pin A of connector is matched to pin 1 of board.

B. INSERT PC BOARD IN HOUSING

1. Turn the keyboard over.
2. Insert it into its housing.
3. Tighten the two screws on either side of the keyboard.

MODULE BOARD SOFTWARE UPDATE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the EPROMS in both single and double-width module boards. These EPROMS contain the operational software for their respective module.

PARTS REQUIRED:

EPROM Set

TOOLS REQUIRED:

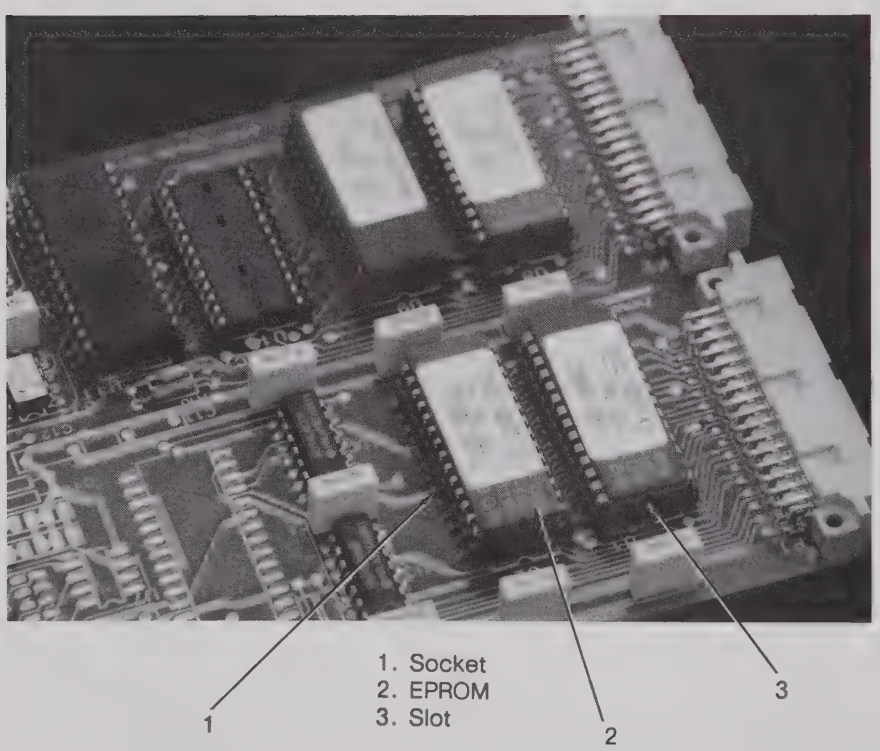
Screwdriver, flatblade, 1/8 inch
Screwdriver, flatblade, 3/16 inch

CAUTION: SAVE the contents of the dictionary on a diskette before performing this procedure.

PROCEDURE 1: EPROM REMOVAL

A. ACCESS THE MODULE SUPPORT BOARD

1. Turn the Controller's power OFF and disconnect the power cord.
2. Turn the Zymate System's power OFF.
3. Using the flatblade screwdriver, turn the front panel fastener's 1/2 turn COUNTER-CLOCKWISE to unlock (click will be heard).
4. Remove the front panel.



B. REMOVE EPROM(S) FROM MODULE BOARD

1. Locate the module board whose software is to be updated.
2. Remove the module board:
   a. Avoid module board damage by first touching the metal on one of the module support trays to dissipate any static charge potential.
   b. If applicable, disconnect the communication cable between the module board and the module.
   c. Grasp the sides of the module board and pull it straight out of the module support tray.
3. Identify the EPROMS on the module board. EPROMS can be distinguished by a label containing the following information:
   a. Software part number (usually five digits long)
   b. Module description (for ex. PEC, MLS, ROBOT, etc.)
   c. Date, version and revision
   d. Zymark Corp. designation
   e. EPROM location number (for ex. #1, #2, etc.)
4. REMOVE EPROM(s):s
   a. Slide a small flatblade screwdriver between the EPROM and its socket.
   b. By using the screwdriver as a lever, carefully ease the EPROM out of its socket.
   c. For module boards with more than one EPROM, make note of the EPROM location number and the socket from which it was removed. This will insure that the replacement EPROMS are correctly located.
   d. Follow steps a – c for all EPROMS.

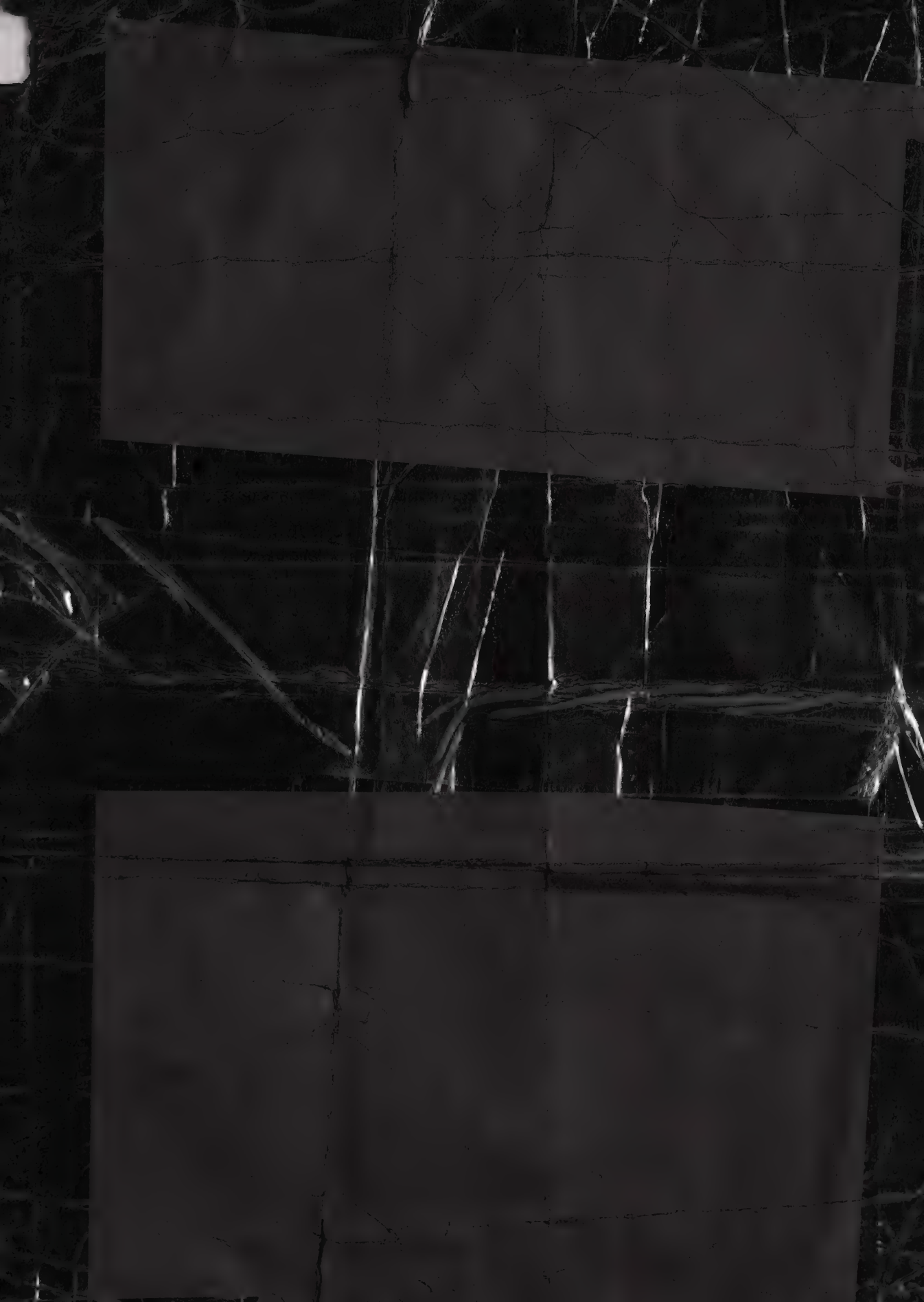
PROCEDURE 2: INSTALLATION

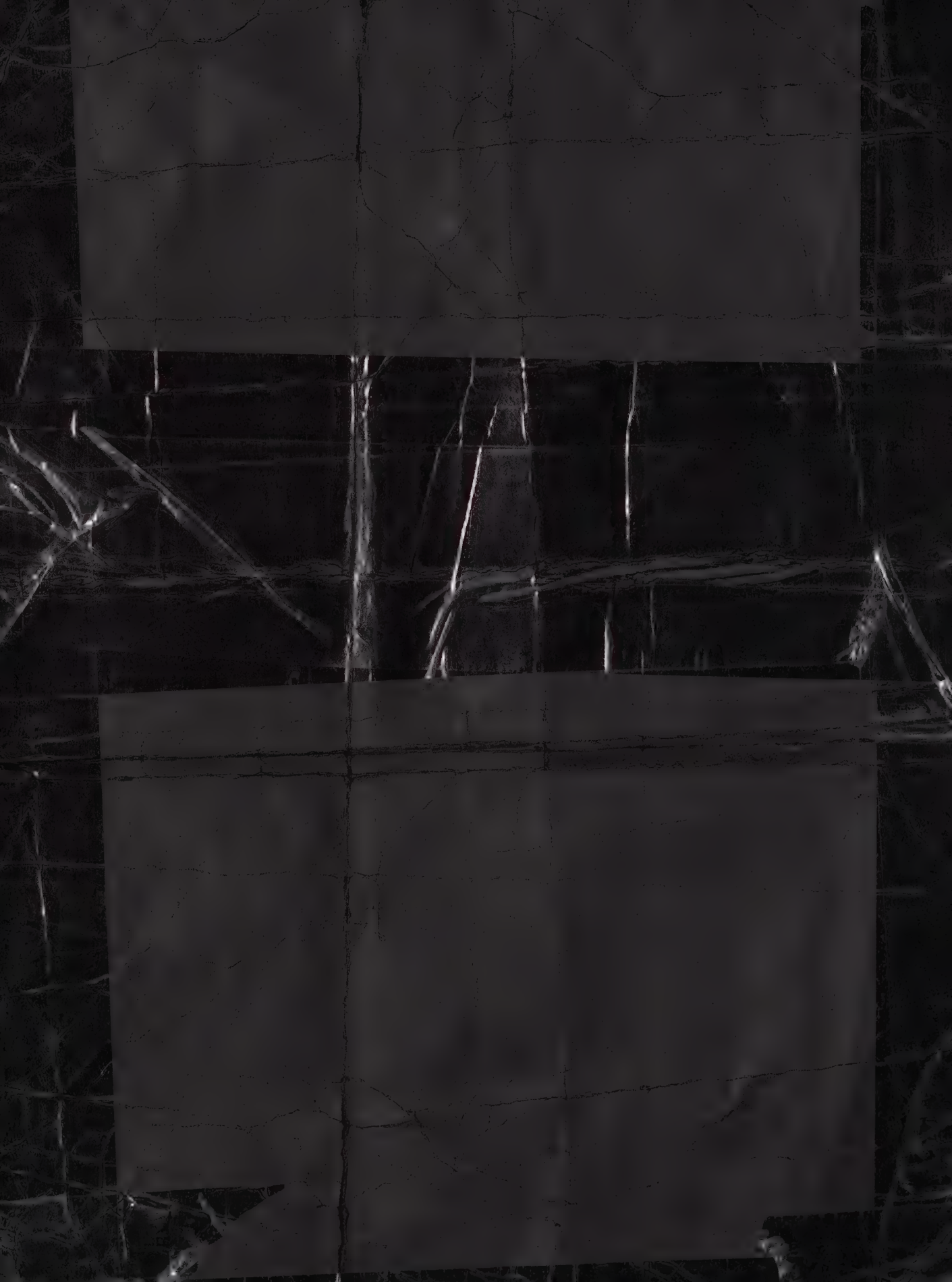
A. INSTALL NEW EPROMS

1. Bend the legs of the EPROMS to fit the socket by laying each EPROM on its side on the benchtop and carefully pushing downward until the legs are perpendicular to the body of the EPROM. Do this on both sets of legs on each EPROM.
2. Refer to the location numbers on the new EPROMS to determine their positioning in the module board.
3. Insert the first EPROM into its appropriate socket by:
   a. Aligning the slot on the EPROM with the slot on the socket.
   b. Carefully aligning each leg with its corresponding socket hole and pressing the EPROM into place.
4. Verify that all legs are fully inserted and the EPROM is evenly seated in the socket.
5. Repeat steps 2 – 4 for each EPROM.

B. INSTALL MODULE BOARD

1. Slide the module board (with the large connector toward the rear) into an available slot on the module support tray.
2. Firmly press inward on the module board to seat its connector in the socket on the module support tray.
3. If applicable, reconnect the module's communication cable to the front of the module board (clip facing up).





PROCEDURE 3: VERIFY OPERATION

1. Reconnect the power cord to the Controller.
2. Turn the Zymate System and Controller power ON.
   a. Wait for the Robot to initialize.

      Confirm initialization by successfully entering and leaving the Robot teaching screen.
3. Verify that the module whose software was just updated is a recognized module by:
   a. Selecting the Bench and module setup screen and observe that the module is listed.
   b. Entering the number preceding the module and verify that the module's screens are operational.

   Refer to the Performance Check section of the module's instruction sheet for failures in step 3a or 3b.

ZYMATE I
KEYBOARD UNIT REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of a keyboard assembly on the Zymate I Controller.

PARTS REQUIRED:

Keyboard, P/N 36217

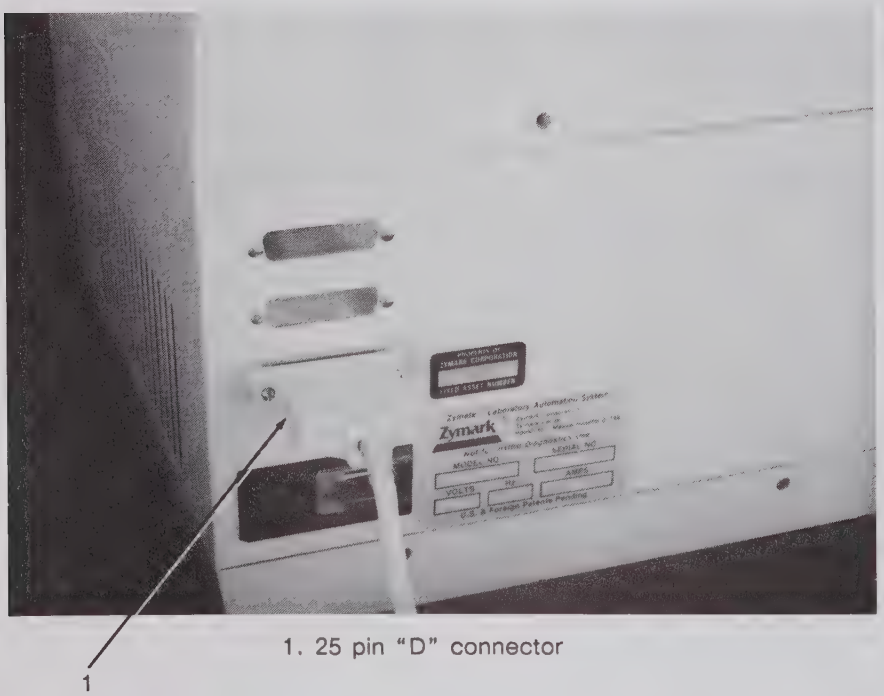
TOOLS REQUIRED:

Screwdriver, blade, 1/8"

PROCEDURE 1: DISASSEMBLY

A. REMOVE CONNECTOR

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Locate the 25 pin "D" type connector at the rear of the Controller.
4. Using a blade screwdriver, loosen the two screws securing the connector.
5. Remove the connector.



1. 25 pin "D" connector

PROCEDURE 2: INSTALLATION

A. ATTACH CONNECTOR

1. Plug in the connector of the new keyboard at the rear of the Controller.

   The connector has a unique shape and cannot be installed incorrectly.

2. Tighten the screws on the connector until it feels secure but not tight.

BATTERY REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and replacement of the lithium batteries on the Zymate Controller's CPU and Extended Memory printed circuit boards.

PARTS REQUIRED:

Lithium Battery, P/N 36365 (3)

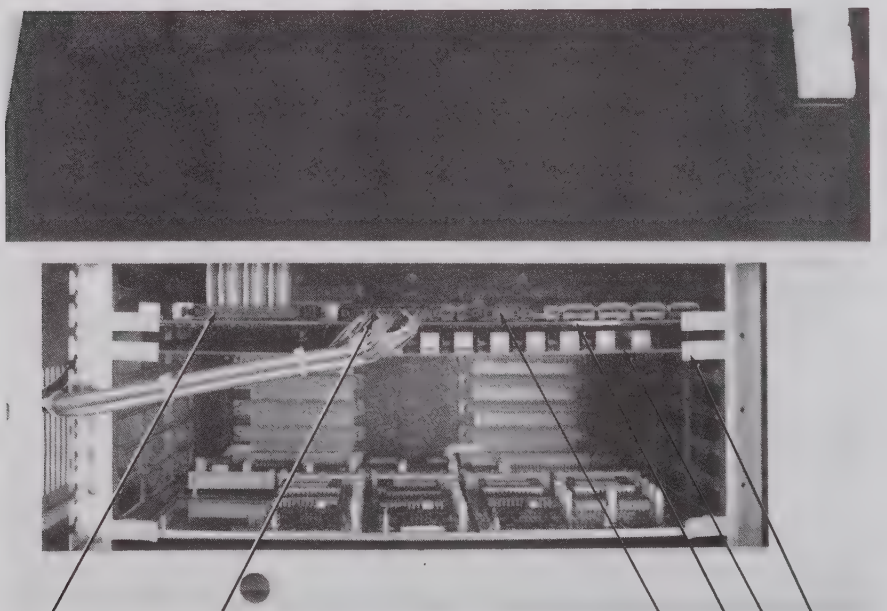
TOOLS REQUIRED:

Screwdriver, blade, 3/16
Needlenose pliers
Soldering iron, 35 wattt
Solder wick
Lead Cutters

CAUTION: Before changing batteries in the Zymate System, SAVE the system dictionary on a floppy disk. The system dictionary contained in the Controller will be lost when the batteries are changed.

A. ACCESS THE PRINTED CIRCUIT BOARDS

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Disconnect the power cord from the rear of the Controller.
4. Using a blade screwdriver, turn the front panel fasteners 1/2 turn COUNTER-CLOCKWISE to unlock. (CLICK will be heard.)
5. Remove the Controller's front panel.



1. Ribbon cable connector
2. Three cable connector
3. Teach pendant connector
4. CPU board
5. Extended memory board
6. Nylon board remover

PROCEDURE 1: CHANGE BATTERY IN EXTENDED MEMORY BOARD

A. REMOVE BATTERY FROM EXTENDED MEMORY BOARD

The extended memory board usually resides just below the CPU board.

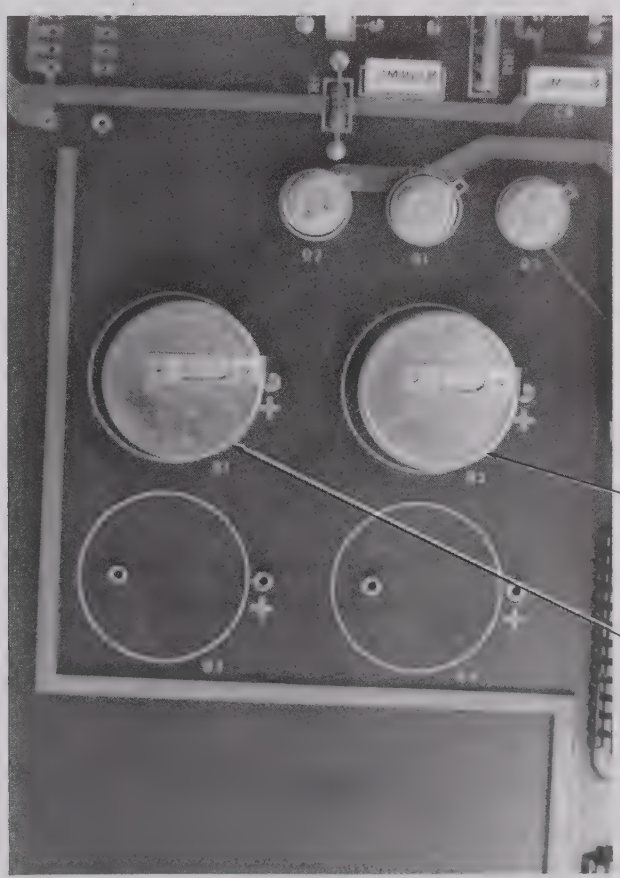
1. Remove the extended memory board.
   a. Grasp the inside edges of the nylon board removers.

      Pull forward and outward on these removers to pry board out of its two rear connectors.

   b. Remove the board by sliding it straight out.

CAUTION: Do not set the board on any conductive material!

2. Identify battery locations B1 and B2.



3. Using the lead cutters, snip the "+" lead.
4. Remove the lead and battery body by heating the land with a soldering iron and removing with needle nose pliers.
5. Clean the land with the soldering iron and solder wick.

B. INSTALL NEW BATTERY ON EXTENDED MEMORY BOARD

1. Insert long lead ("+") of the new battery through the hole marked "+".
2. Solder the leads.

C. INSTALL THE EXTENDED MEMORY BOARD

1. Align the extended memory board with the slots at the edges of the card guide.

   Do NOT place the board in the topmost slot of the card cage.
2. Slide it into the Controller.
3. Exert a pressure of approximately 20lbs. with your palm to seat the board in its sockets at the rear of the Controller.

PROCEDURE 2: CHANGE BATTERY IN CPU BOARD

A. REMOVE BATTERY FROM CPU BOARD

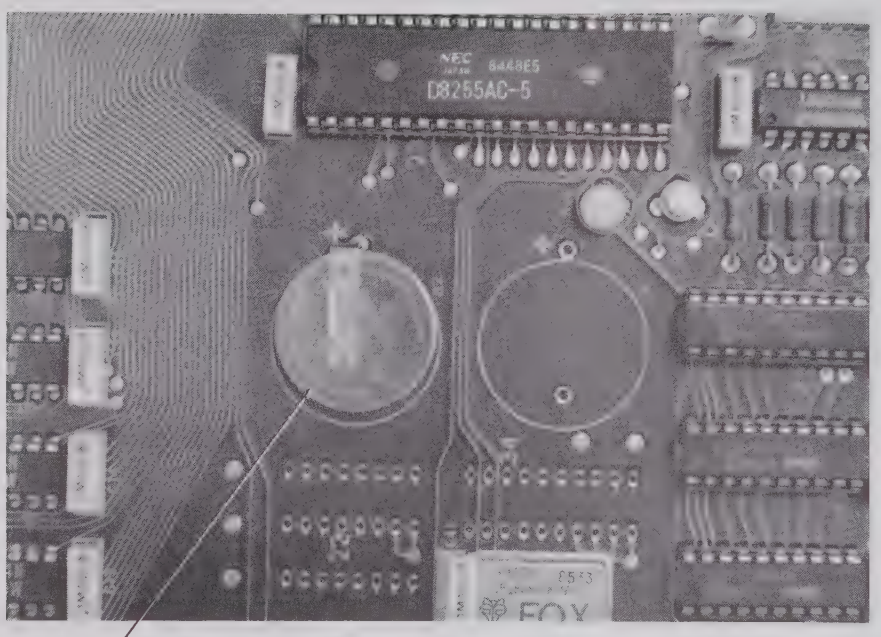
The CPU board is the topmost board in the Controller.

1. Remove the CPU board.
   a. Unplug the ribbon cable connector from the leftmost socket.
      1. Spread the black locking tabs on either side of the connector.
      2. Remove the connector from its socket.
      3. Push the cable up slightly so it is clear of the board.
   b. Unplug the three-cable connector from the center socket.
   c. If a teach pendant is being used, unplug it from the rightmost socket.
   d. Grasp the inside edges of the two nylon board removers.

      Pull forward and outward on these removers to pry the board out of its two rear connectors.
   e. Remove the board from the Controller by sliding it straight out.

CAUTION: Do not set the board on any conductive material!

2. Identify battery locations B1 and B2.



1. Battery (CPU Board)

3. Using the lead cutters, snip the "+" lead.
4. Remove the lead and the battery body by heating the land with a soldering iron and removing with needle nose pliers.
5. Clean the land with soldering iron and solder wick.

B. INSTALL NEW BATTERY IN CPU BOARD

1. Insert the long lead ("+") of the new battery through the hole marked "+".
2. Solder the leads.

C. INSTALL CPU BOARD IN CONTROLLER

1. Align the CPU board with the slots at the edges of the card guide.

   Do NOT place the board in the topmost slot of the card cage. It is usually placed in the second slot, but may be placed in other slots within reach of the connectors.

2. Slide it into the Controller.
3. Exert a pressure of approximately 20lbs. with your palm to seat the board in its sockets at the rear of the Controller.
4. Plug the ribbon cable into the leftmost socket on the board.
5. Plug the three-cable connector into its socket.
6. Plug the teach pendant into its socket if used.

PROCEDURE 3: CHECKOUT THE SYSTEM

A. REPLACE THE FRONT PANEL

1. Secure in place by turning the front panel fasteners 1/2 turn CLOCKWISE.

B. VERIFY OPERATION

1. Turn the Zymate Controller and System power ON.
2. Wait for the Robot to initialize.
3. Go to the Direct Control screen.
4. Display the system dictionary.
   a. Verify that the primitive commands and modules exist in the system dictionary.
   b. LOAD the system dictionary from the disk.
5. Repeat step 4 after the dictionary is loaded from the disk, verifying that the disk contents have been successfully loaded.

DISK DRIVE REPLACEMENT PROCEDURE FOR ZYMATE I CONTROLLERS

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the disk drive assembly in the Zymate I Controller.

PARTS REQUIRED:

Disk Drive, P/N 36619

TOOLS REQUIRED:

Screwdriver, Philips, #1
Screwdriver, flatblade, 3/16

CAUTION: If possible, SAVE the contents of the dictionary onto a new diskette before performing this procedure.

PROCEDURE 1: DISASSEMBLY

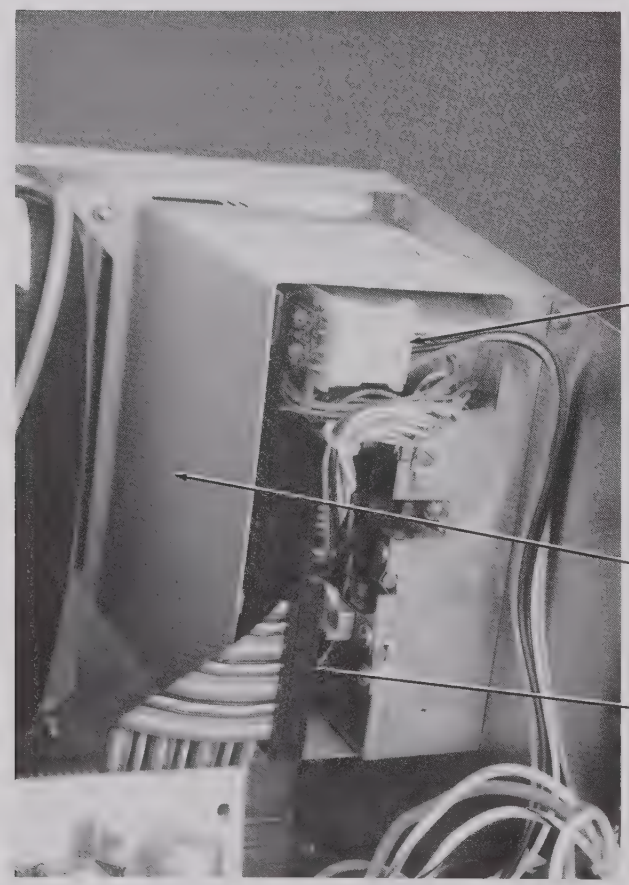
A. ACCESS DISK DRIVE

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Disconnect the power cord from rear of the Controller.
4. Using a Phillips screwdriver, remove the four screws securing the top cover of the Controller.
5. Remove the cover.
6. Using a blade screwdriver, remove the four 6/32 screws securing the sheet metal monitor cover.
7. Remove the sheet metal monitor cover.
8. Remove the eight plastic function key covers on the front of the screen.
9. Remove the plexiglass window.

B. REMOVE THE DISK DRIVE

1. Unplug the top and bottom connectors from the rear of the floppy drive unit.
2. Remove one screw from the top of the drive and four screws from its side.

   It will be necessary to support the drive unit when removing the last screw.
3. Slide the disk drive unit out of the Controller.
4. Remove the sheet metal drive unit cover.

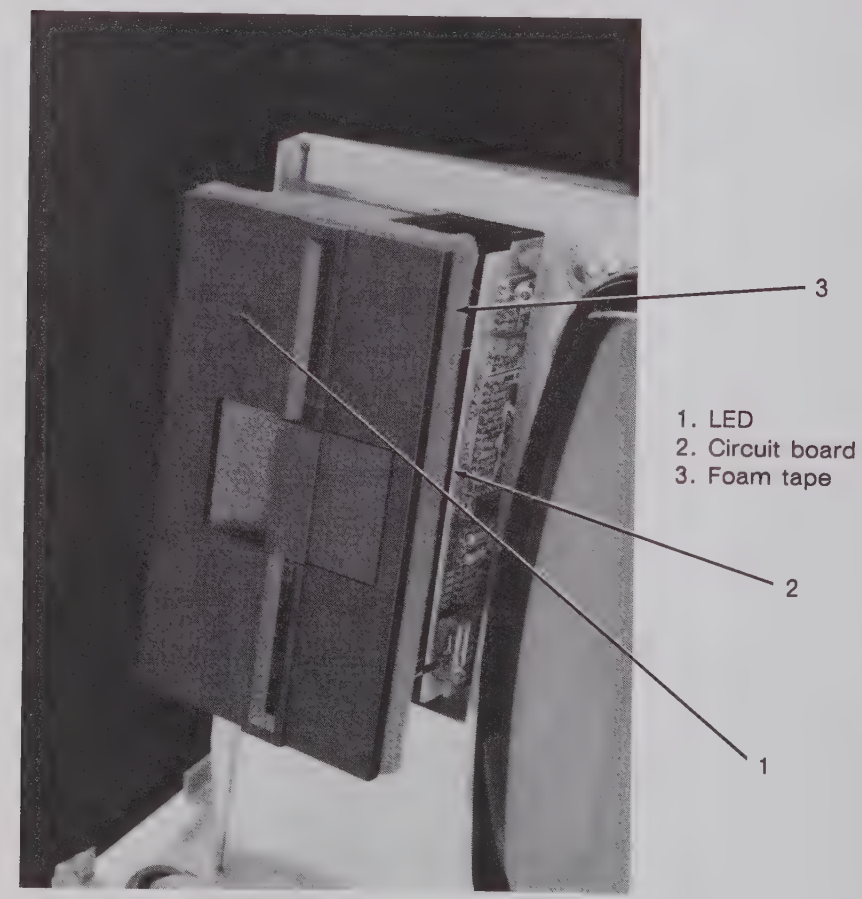


1. Top connector
2. Sheet metal drive unit cover
3. Bottom connector

PROCEDURE 2: INSTALLATION

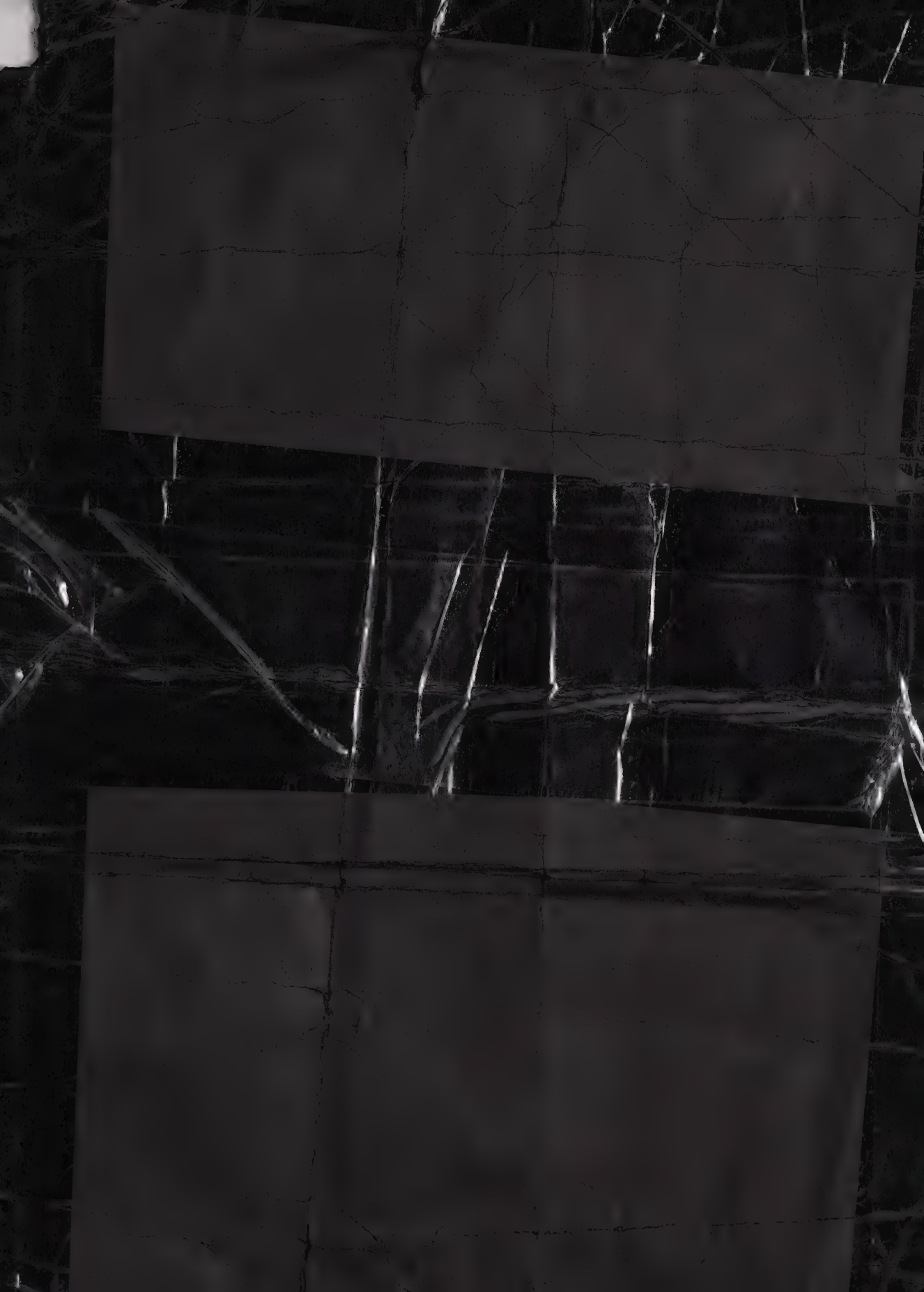
A. INSERT THE DISK DRIVE

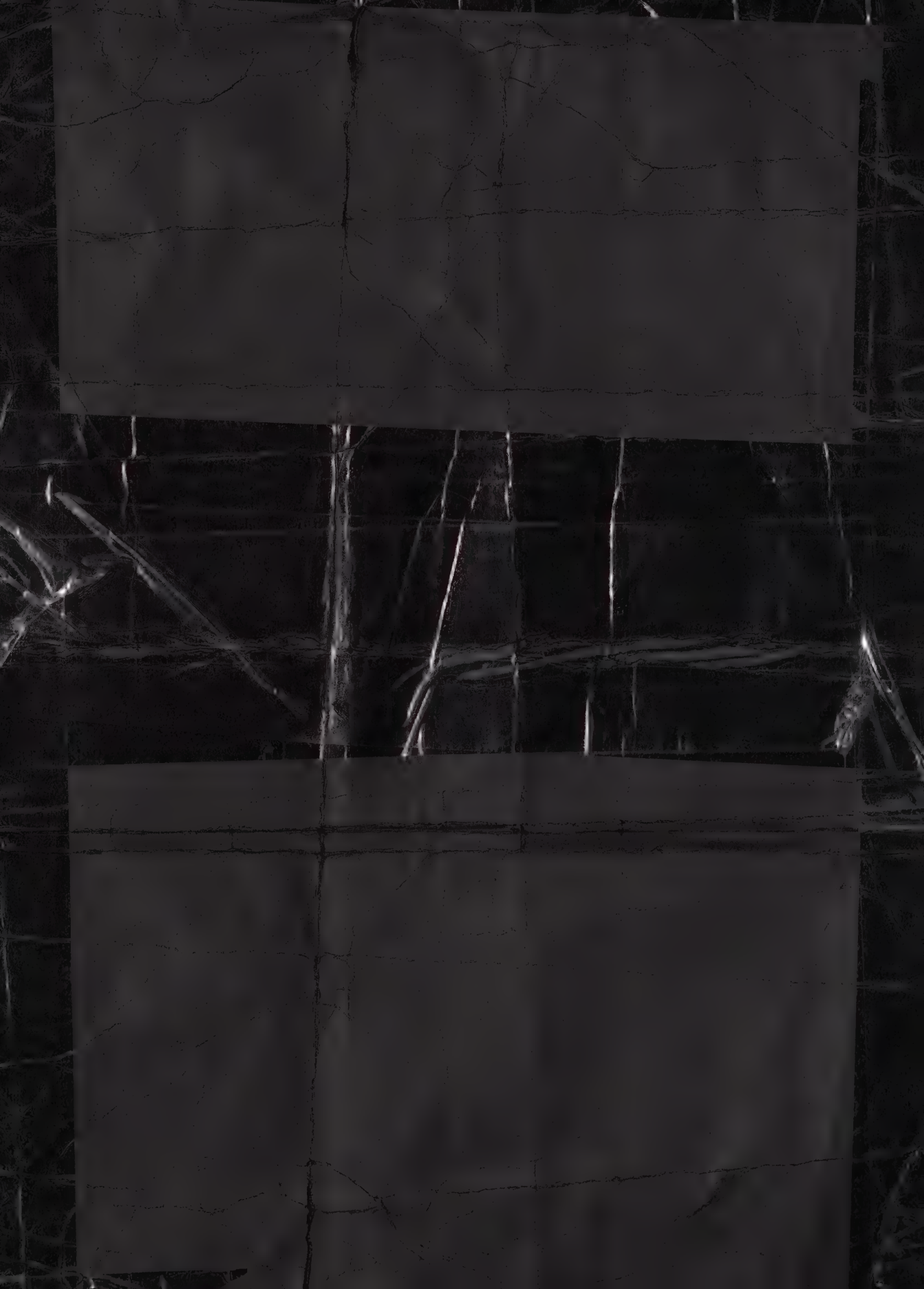
1. Place the foam tape around the disk drive unit.
2. Slide the disk drive unit into the front of the Controller positioning the LED towards the top and the circuit board towards the right.
3. Position the drive unit sheet metal cover around the disk unit as shown in previous photo.



1. LED
2. Circuit board
3. Foam tape

4. Secure the unit with four screws on the side and one on the top.
5. Secure the sheet metal cover with one screw on the top.
6. Plug in the two connectors at the rear of the drive unit.





REASSEMBLE CONTROLLER

1. Replace the plexiglass window.
2. Replace the eight plastic function keys.
3. Install the sheet metal monitor cover securing with the four 6/32 screws.
4. Replace the top cover using care to align the plexiglass window in the top channel of the cover.
5. Secure the top cover with the screws.
6. Plug the power cord into the rear of the Controller.

PROCEDURE 3: VERIFY OPERATION

1. Holding the second and fourth function keys IN, turn the Zymate Controller and System power ON.

   This action deletes all module commands, programs and variables currently contained in the system dictionary.

   a. Wait for the Robot to intialize.

2. Verify disk operation.

   a. Go to the Direct Control screen.

   b. List the dictionary.

      Only the "primitive" information should be displayed.

   c. Load the system dictionary previously saved onto disk.

      1. Verify that the disk contents loaded properly by listing the dictionary.

TODD POWER SUPPLY RETROFIT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the replacement of a Power One Power Supply with a Todd Power Supply in the Zymate I Controller.

PARTS REQUIRED:

Todd Power Supply and Plate Assembly
Retrofit Disk Drive Power Cable
Cable Ty
Wire Nut
Piece of Electrical Tape (found on plate of Power Supply)
Small Voltage Label

TOOLS REQUIRED:

Philips Screwdriver
Flatblade Screwdriver
Screw Starter (helpful)
Wire Cutter
Voltmeter
Small Flatblade Screwdriver

PROCEDURE 1: REMOVAL

1. Turn the power OFF and disconnect the Power Cord from the Controller.
2. Remove the four flat head phillips screws holding the Controller cover.
3. Remove the cover to access the four pan head screws holding the metal shield in place.
4. Remove these four screws and remove the shield.

*****WARNING*****
HIGH VOLTAGE EXPOSED!

5. Making sure that the power cord has been removed, remove all the wires at each end of the Power One Supply terminal blocks.
6. Remove the Disk Drive power supply cable from the back of the Disk Drive.
7. Carefully remove and set aside the four pan head screws holding the Power One Supply in place.
8. Remove the Power One Supply from the Controller being careful not to damage the back of the CRT.
9. Facing the Controller from the rear, note that the AC voltage wires are to the left. Remove the one pan head screw nearest these wires and discard. If this is not done, the new power supply won't sit flat on the plate. (See Diagram 1 for the location of this screw.)

PROCEDURE 2: INSTALLATION

The Todd Power supply is shipped with the Input Select Jumper INSTALLED for domestic use, and REMOVED for international use. (See Diagram #1).

1. Remove the black electrical tape mounted to the Plate Assembly and set aside for step 6.
2. Facing the unit from the back, place the new supply in the Controller with the longer, labelled terminal block to the right. Install by using the four pan head screws previously held aside.
3. Plug the new Disk Drive power cable, provided with the kit, into the back of the drive.
4. One at a time, carefully remove the screws from the long terminal block (right side) and install the corresponding wire or wires under that screw. (Follow Diagram 1)
5. Carefully remove the screws from the short Terminal Block (left side) and attach the white and blue wires as shown.
6. Cut off the lug on the black wire, install the Wire Nut and tape in place using the piece of electrical tape provided. This avoids shorting out the black wire which is no longer used.
7. Ty-wrap the black, white and blue wires together or to the Ty-wrap Platform (if one is present) using the Ty-wrap provided in the kit.
8. Install the grey chassis grounding wire from the CHS GND terminal of the long Terminal Block to the nearest Power Supply Bracket mounting screw.
9. Slide the brown connector of the Disk Drive Power cable through the slot on the right panel of the monitor frame and mount it to the outside using the adhesive fastener on the connector. (See Diagram #2).
10. Place the small Voltage Label on the panel, directly above the connector.
11. Check that all fasteners and wires are installed properly.
12. Plug in the unit.

*****WARNING*****
HIGH VOLTAGE EXPOSED!

13. Turn on the Controller.
14. With a DVM set to the 20V DC scale, read across the slots in the brown connector that correspond to the +5V and common lines. (Red and black wires). Adjust the 5V pot (shown in both diagrams) if necessary.
15. Re-install the metal shield over the back of the unit with the four pan head screws.

16. Re-install the Controller cover using the four flat head Phillips screws.

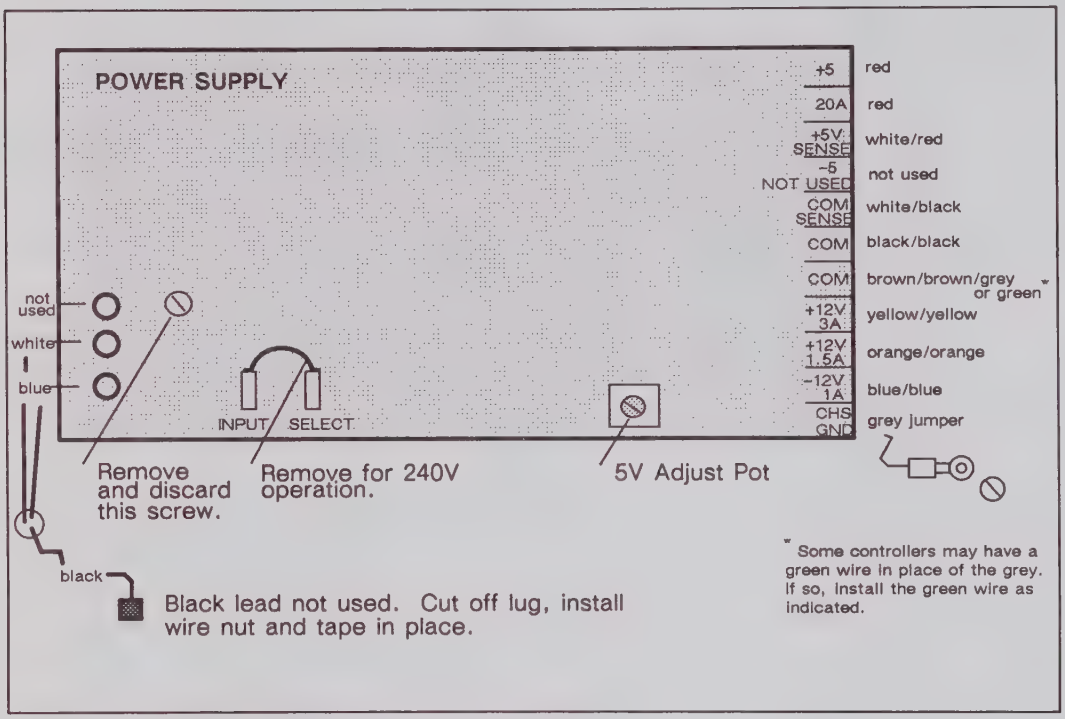


DIAGRAM 1

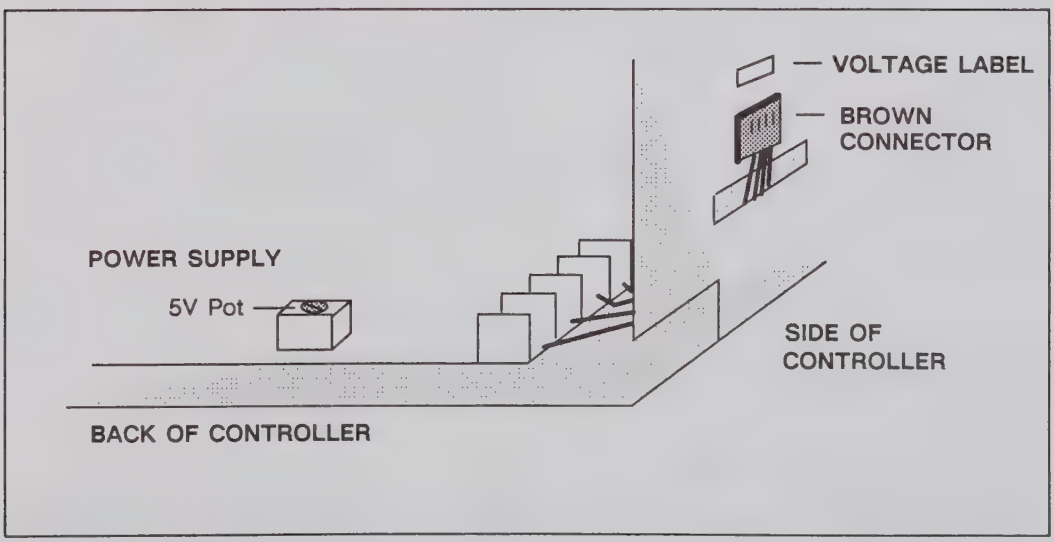


DIAGRAM 2

ZYMATE I CONTROLLER
POWER SUPPLY ADJUSTMENT PROCEDURE
(Power One power supply)

PROCEDURE SCOPE:

This service procedure describes the adjustments to the +5V, +12V, -12V, and OPT V power supplies in the Zymate I Controller. This procedure pertains ONLY to those Zymate I Controllers containing Power One power supplies. Refer to C59 for adjustments to Zymate I Controllers fitted with Todd power supplies.

PARTS REQUIRED:

None

TOOLS REQUIRED:

Screwdriver, Philips #1
Screwdriver, Flatblade 3/16
Screwdriver, precision, 1.2mm
Digital Voltmeter (DVM)

PROCEDURE 1: ACCESS POWER SUPPLY

1. Turn the Controller's power OFF.
2. Turn the Zymate System's power OFF.
3. Using a Phillips screwdriver, remove the four screws securing the top cover of the Controller.
4. Remove the cover and set aside.
5. Using a blade screwdriver, remove the four 6/32 screws securing the sheet metal monitor cover.
6. Remove the monitor cover.
7. Set the DVM to: Volts, DC, 20V scale.
8. Turn the Zymate System and Controller power ON.

Note: Terminals can be accessed through the side of the Controller.

1. Terminals

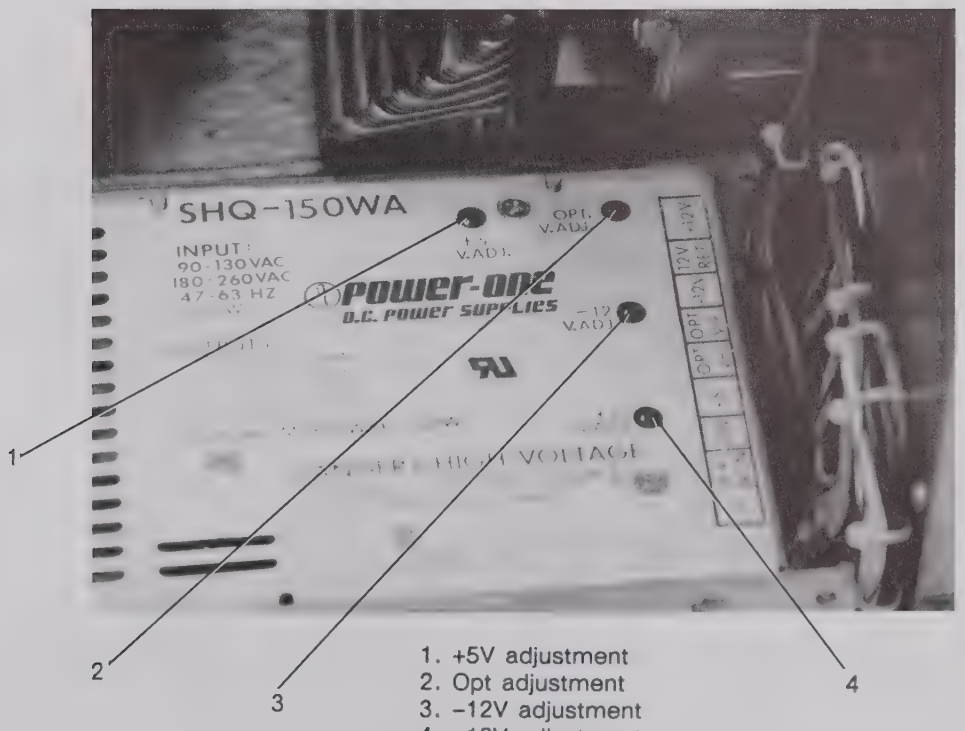
*****WARNING*****
HIGH VOLTAGE EXPOSED!

PROCEDURE 2: +5V ADJUSTMENT

Make sure that the +5V adjustment is the first adjustment made to the power supply.

1. Touch the DVM voltage lead to the +S terminal.
2. Touch the common lead of the DVM to the –S terminal.
3. Check for a voltage reading of +5.00 volts.
4. Using a small screwdriver, adjust the pot marked +5V ADJ on the cover of the power supply unit until the voltage reads +5.00 on the DVM.

Note: The +5V adjustment differs from all other voltage adjustments within the supply in that CCW rotation increases voltage.



1. +5V adjustment
2. Opt adjustment
3. –12V adjustment
4. +12V adjustment

PROCEDURE 3: +12V ADJUSTMENT

1. Touch the DVM voltage lead to the +12V terminal.
2. Touch the common lead of the DVM to the 12V RTN terminal.
3. Check for a voltage reading of +12.00 volts.
4. Using a small screwdriver, adjust the pot marked +12V ADJ on the cover of the power supply unit until the voltage reads +12.00 on the DVM.

PROCEDURE 4: −12V ADJUSTMENT

1. Touch the DVM voltage lead to the −12V terminal.
2. Touch the common lead of the DVM to the 12V RTN terminal.
3. Check for a voltage reading of −12.00 volts.
4. Using a small screwdriver, adjust the pot marked −12V ADJ on the cover of the power supply unit until the voltage reads −12.00 volts on the DVM.

PROCEDURE 5: OPT V ADJUSTMENT

1. Touch the DVM voltage lead to the OPT V + terminal.
2. Touch the common lead of the DVM to the OPTV − terminal.
3. Check for a voltage reading of +12.00 volts.
4. Using a small screwdriver, adjust the pot marked OPT.V.ADJ on the cover of the power supply unit until the voltage reads +12.00 volts on the DVM.

PROCEDURE 6: REASSEMBLY

1. Turn the Zymate System's power OFF.
2. Install the sheet metal cover and secure with the four screws.
3. Install the Controller cover using care to align the plexiglass window in the top channel of the cover.
4. Secure the top cover with the four screws.

ZYMATE I CONTROLLER
POWER SUPPLY ADJUSTMENT
(Todd Power Supply)

PROCEDURE SCOPE:

This service procedure covers the adjustment of the +5V supply in the Zymate I Controller. This procedure pertains only to those Zymate I Controllers containing Todd Power Supplies. Refer to C58 for adjustments to Zymate I Controllers fitted with Power One Power Supplies.

PARTS REQUIRED:

None

TOOLS REQUIRED:

Screwdriver, Philips #1
Screwdriver, Flatblade 3/16
Screwdriver, precision flatblade, 1.2mm
Digital Voltmeter (DVM)

PROCEDURE 1: ACCESS POWER SUPPLY

1. Turn the Controller's power OFF.
2. Turn the Zymate System's power OFF.
3. Using a Phillips screwdriver, remove the four screws securing the top cover of the Controller.
4. Remove the cover and set aside.
5. Using a blade screwdriver, remove the four 6/32 screws securing the sheet metal monitor cover.
6. Remove the monitor cover.

*****WARNING*****
HIGH VOLTAGE EXPOSED!

PROCEDURE 2: ADJUST THE +5V SUPPLY

1. Turn the System and Controller power ON.
2. With a DVM set to the 20V DC scale, read across the slots in the brown connector that correspond to the +5V and common lines. (Red and black wires). Adjust the 5V pot (shown in both diagrams) so that the DVM reads +5.00 volts.
3. Reinstall the metal shield over the back of the unit with the four pan head screws.
4. Reinstall the Controller cover using the four flat head Phillips screws.

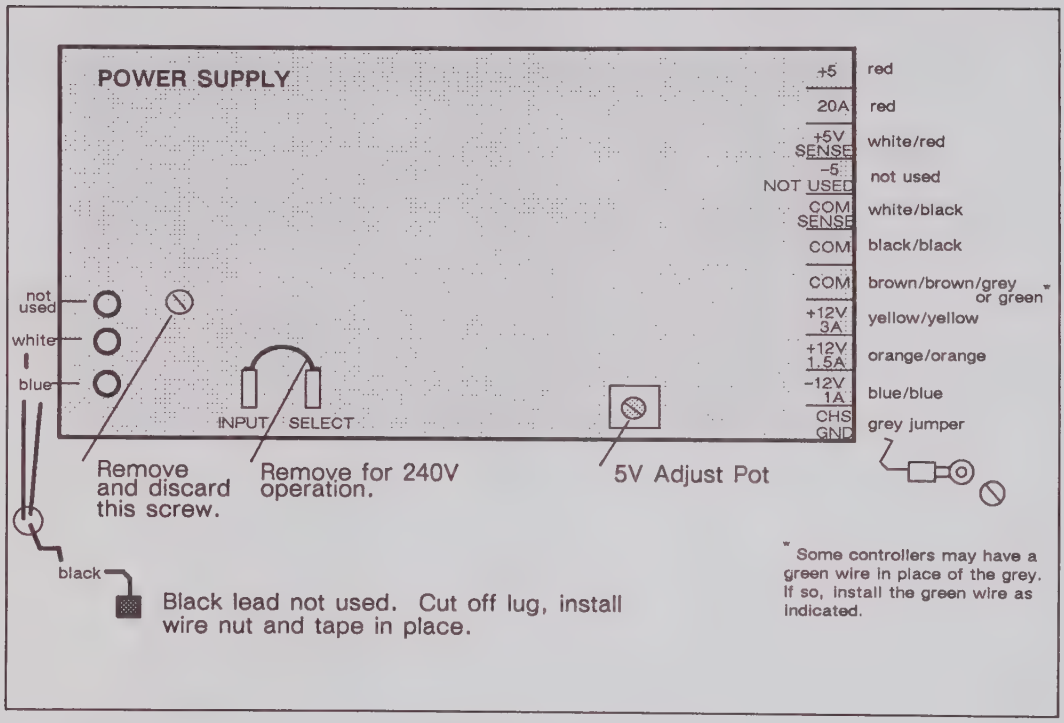


DIAGRAM 1

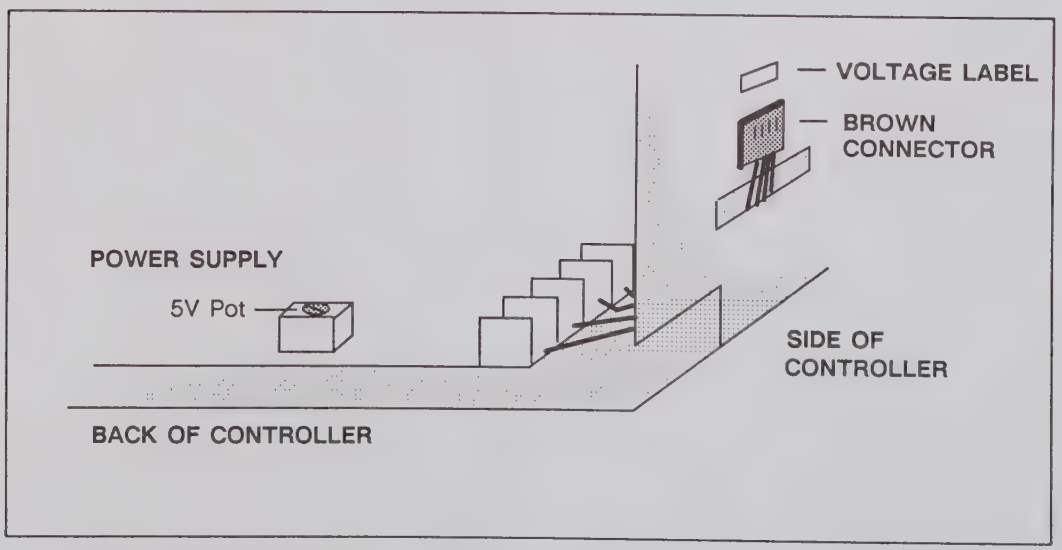


DIAGRAM 2

TODD POWER SUPPLY REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the replacement of a Todd Power Supply within the Zymate I Controller.

PARTS REQUIRED:

Todd Power Supply and Plate Assembly
Retrofit Disk Drive Power Cable
Cable Ty

TOOLS REQUIRED:

Philips Screwdriver
Flatblade Screwdriver
Screw Starter (helpful)
Wire Cutter
Voltmeter
Small Flatblade Screwdriver

PROCEDURE 1: REMOVAL

1. Turn the power OFF and disconnect the Power Cord from the Controller.
2. Remove the four flat head Phillips screws holding the Controller cover.
3. Remove the cover to access the four pan head screws holding the metal shield in place.
4. Remove these four screws and remove the shield.

> ***WARNING***
> HIGH VOLTAGE EXPOSED!

5. Making sure that the power cord has been removed, remove all the wires at each end of the terminal blocks.
6. Remove the Disk Drive power supply cable from the back of the Disk Drive. Pry the brown connector off the side of the monitor panel using a small screwdriver or similar tool.
7. Carefully remove and set aside the four pan head screws holding the supply in place.
8. Remove the supply from the Controller being careful not to damage the back of the CRT.

PROCEDURE 2: INSTALLATION

The Todd Power supply is shipped with the Input Select Jumper INSTALLED for domestic use, and REMOVED for international use. (See Diagram #1).

1. Facing the unit from the back, place the new supply in the Controller with the longer, labelled terminal block to the right. Install by using the four pan head screws previously held aside.
2. Plug the new Disk Drive power cable, provided with the kit, into the back of the drive.
3. One at a time, carefully remove the screws from the long terminal block (right side) and install the corresponding wire or wires under that screw. (Follow Diagram 1)
4. Carefully remove the screws from the short Terminal Block (left side) and attach the white and blue wires as shown.
5. Ty-wrap the black, white and blue wires together or to the Ty-wrap Platform (if one is present) using the Ty-wrap provided in the kit.
6. Install the grey chassis grounding wire from the CHS GND terminal of the long Terminal Block to the nearest Power Supply Bracket mounting screw.
7. Slide the brown connector of the Disk Drive Power cable through the slot on the right panel of the monitor frame and mount it to the outside using the adhesive fastener on the connector. (See Diagram #2).
8. Check that all fasteners and wires are installed properly.
9. Plug in the unit.

*****WARNING*****
HIGH VOLTAGE EXPOSED!

10. Turn on the Controller.
11. With a DVM set to the 20V DC scale, read across the slots in the brown connector that correspond to the +5V and common lines. (Red and black wires). Adjust the 5V pot (shown in both diagrams) if necessary.
12. Re-install the metal shield over the back of the unit with the four pan head screws.
13. Re-install the Controller cover using the four flat head Phillips screws.

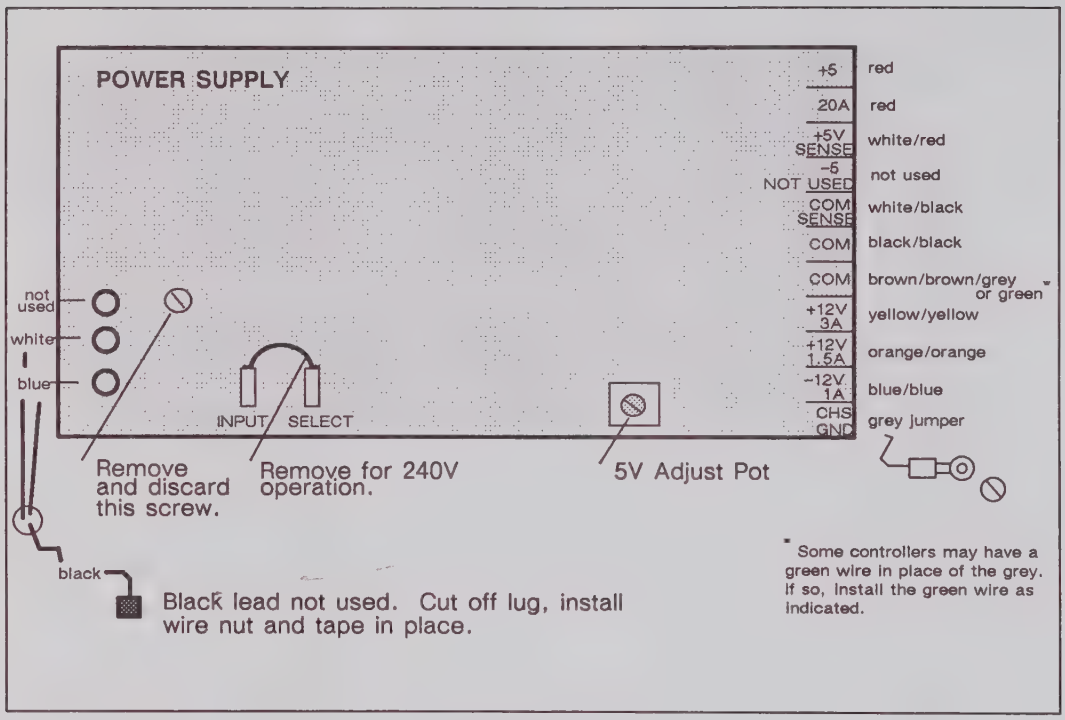


DIAGRAM 1

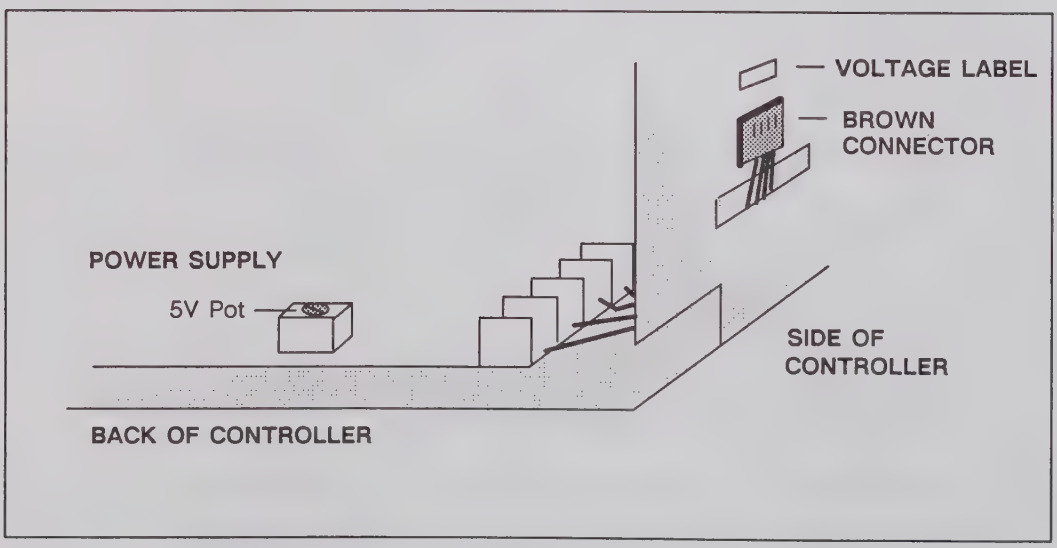


DIAGRAM 2

ZYMATE I CONTROLLER
PRINTED CIRCUIT BOARD REPLACEMENT

PROCEDURE SCOPE:

This service procedure covers the removal and replacement of the Zymate I Controller's CPU and extended memory printed circuit boards.

PARTS REQUIRED:

CPU Board, P/N 36026
Memory Board, P/N 36915

TOOLS REQUIRED:

Screwdriver, blade, 3/16

CAUTION: Before performing this Controller service procedure, SAVE the system dictionary on a floppy disk. This will ensure that previously created module commands and programs will not be inadvertently lost.

ACCESS THE PRINTED CIRCUIT BOARDS

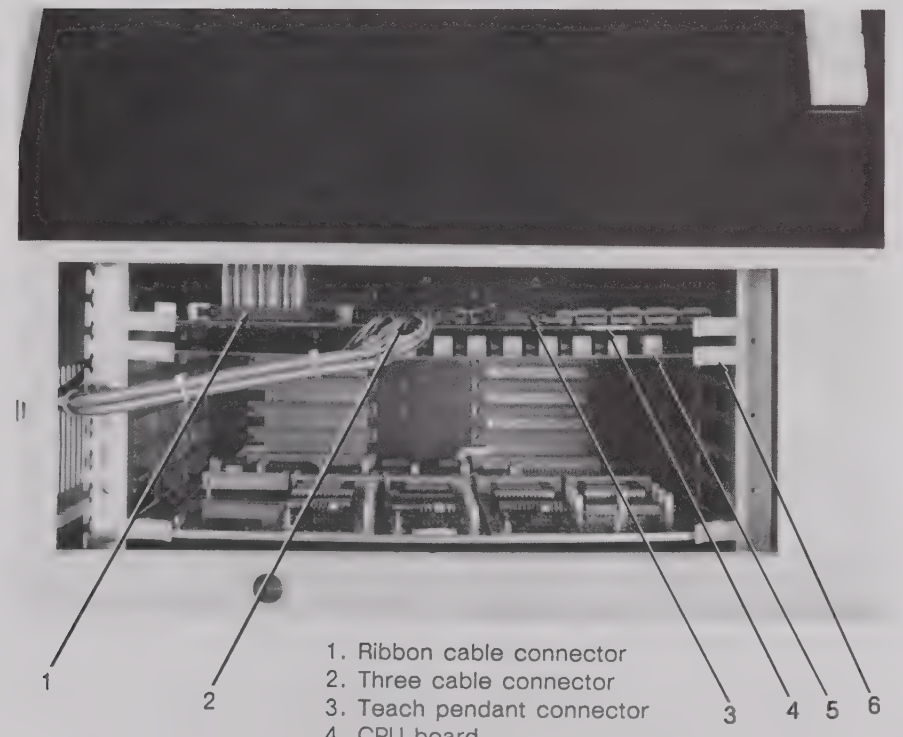
1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Disconnect the power cord from the rear of the Controller.
4. Using a blade screwdriver, turn the front panel fasteners 1/2 turn COUNTER-CLOCKWISE to unlock. (CLICK will be heard.)
5. Remove the Controller's front panel.

PROCEDURE 1: CPU BOARD

A. REMOVE THE CPU BOARD

The CPU Board is the topmost board in the Controller. It is located in the second physical slot from the top of the card cage.

1. Unplug the ribbon cable connector from the leftmost socket.
   a. Spread the black locking tabs on either side of the connector.
   b. Remove the connector from its socket.
   c. Push the cable up slightly so it is clear of the board.
2. Unplug the three-cable connector from the center socket.



1. Ribbon cable connector
2. Three cable connector
3. Teach pendant connector
4. CPU board
5. Extended memory board
6. Nylon board remover

3. If a teach pendant is being used in the system, unplug it from the rightmost socket.
4. Grasp the inside edges of the two nylon board removers.
   a. Pull forward and outward on these removers.

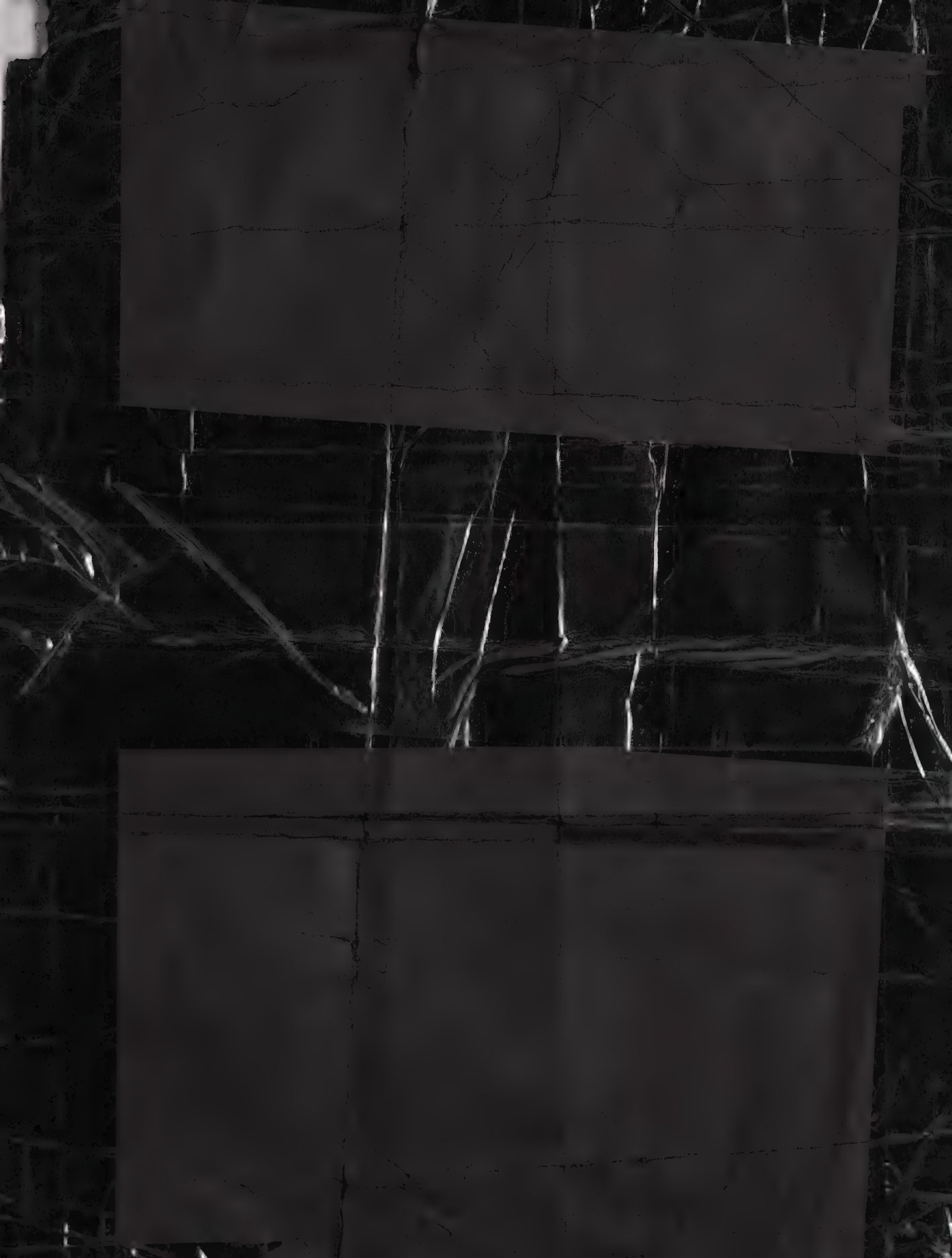
      This will pry the board out of its two rear connectors.
5. Remove the board from the Controller by sliding it straight out.

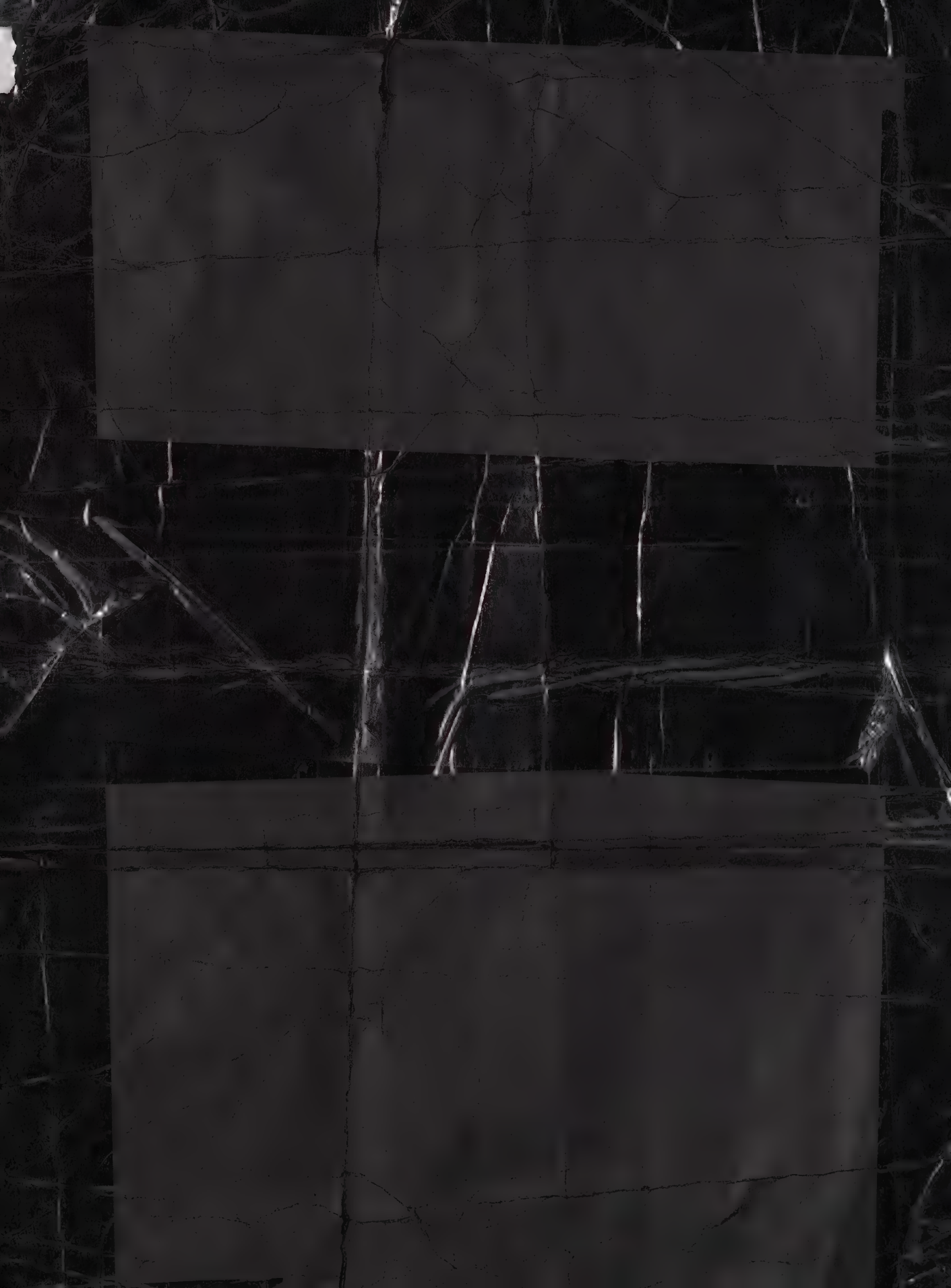
CAUTION: Do not set the board on any conductive material!

B. REPLACE THE CPU BOARD

1. Align the CPU board with the slots at the edges of the card guide.

   Do NOT place the board in the topmost slot of the card cage. It is usually placed in the second slot, but may be placed in other slots within reach of the connectors.
2. Slide it into the Controller.
3. Exert a pressure of approximately 20 lbs with your palm to seat the board in its sockets at the rear of the Controller.
4. Plug the ribbon cable into the leftmost socket on the board.
5. Plug the three-cable connector into its socket.
6. Plug the teach pendant into its socket if used.





PROCEDURE 2: EXTENDED MEMORY BOARD

A. REMOVE THE EXTENDED MEMORY BOARD

The extended memory board usually resides just below the CPU board, but may be found in any board slot in the card cage except for the top two slots.

1. Grasp the inside edges of the nylon board removers.
   a. Pull forward and outward on these removers.

      This will pry the board out of its two rear connectors.
2. Remove the board by sliding it straight out.

CAUTION: Do not set the board on any conductive material!

B. INSTALL THE EXTENDED MEMORY BOARD

1. Align the extended memory board with the slots at the edges of the card guide.

   Do NOT place the board in the topmost slot of the card cage.
2. Slide it into the Controller.
3. Exert a pressure of approximately 20 lbs. with your palm to seat the board in its sockets at the rear of the Controller.

PROCEDURE 3: VERIFY OPERATION

A. REPLACE THE FRONT PANEL

1. Secure in place by turning the front panel fasteners 1/2 turn CLOCKWISE or until a "click" is heard.
2. Plug the power cord into the rear of the Controller.
3. Turn the Zymate System and Controller power ON.
   a. Wait for the Robot to initialize.
4. Verify Controller operation.
   a. Go to the various pages in the system.
   b. Load the dictionary from the disk.
      1. Verify that the system dictionary was loaded properly.

ZYMATE I CRT ADJUSTMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the adjustments that can be made to the screen display on the CRT monitor for the Zymate I Controller.

PARTS REQUIRED:

None

TOOLS REQUIRED:

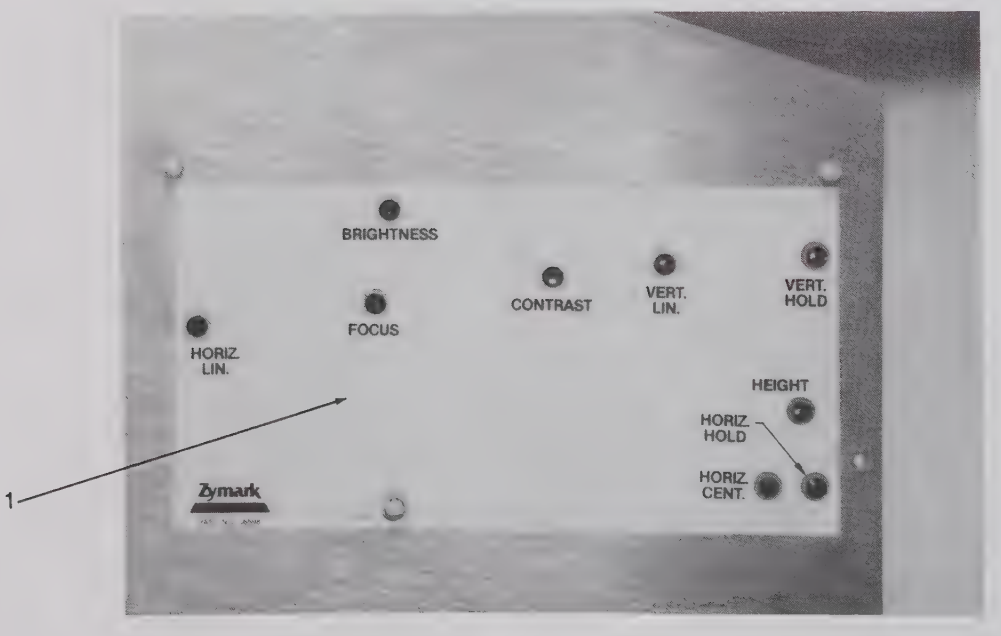
Screwdriver, Philips, #1
Screwdriver, flatblade, 3/16
Plastic CRT adjustment tool
Ruler

A. ACCESS THE ADJUSTMENT CONTROLS

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Using a Phillips screwdriver, remove the four screws securing the top cover of the Controller.
4. Remove the cover.
5. Using a blade screwdriver, remove the four 6/32 screws securing the sheet metal monitor cover.
6. Remove the sheet metal monitor cover.
7. Turn the Zymate System and Controller power ON.

> ***WARNING***
>
> **Beware of high voltage! Keep hands away from rear of CRT.**

8. Locate the labelled adjustment controls on the side of the monitor.



1. CRT adjustments

B. ADJUST FOR UNSTABLE PICTURE

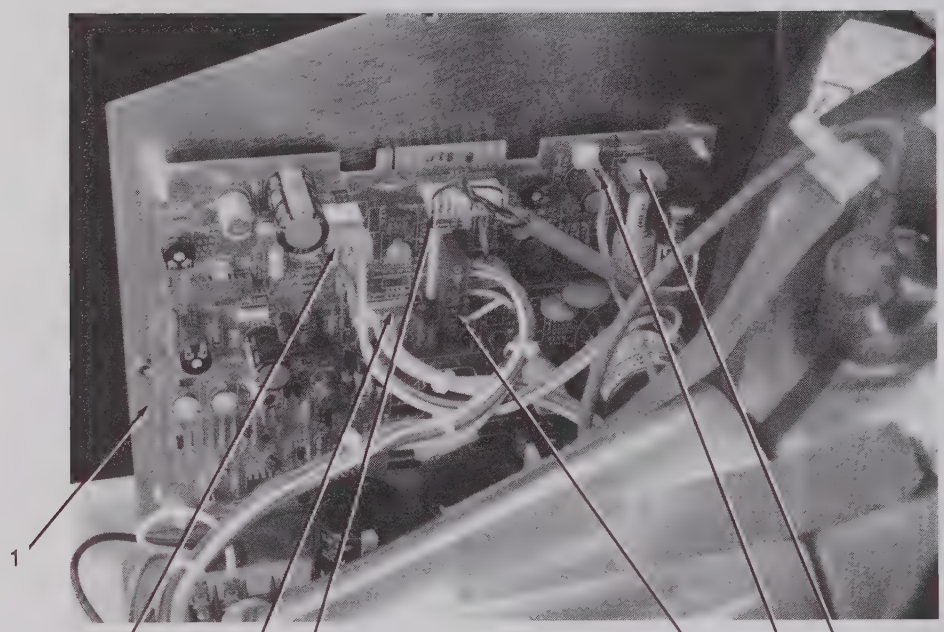
1. Turn the HORIZONTAL HOLD pot in both directions until the trace becomes unstable.
2. Turn the HORIZONTAL HOLD pot until it is in the middle of the stable range.

   This stable range is likely to be fairly small.
3. Turn the VERTICAL HOLD pot fully clockwise.

   The screen will be rolling upward.
4. Turn the VERTICAL HOLD pot slowly counter-clockwise until the picture rolls down.
5. Turn the VERTICAL HOLD pot 1/8 turn clockwise.

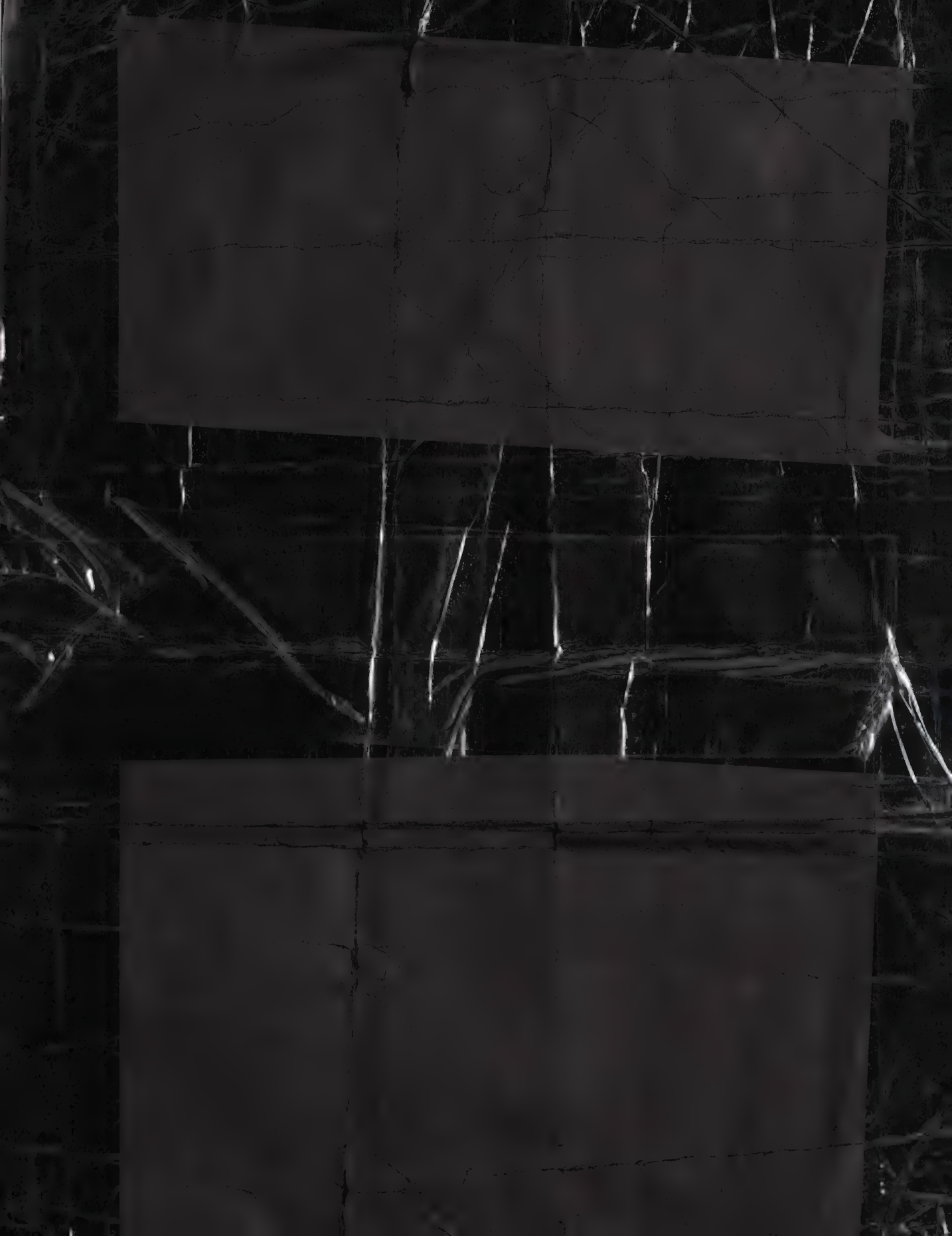
C. ADJUST CHARACTER SIZE

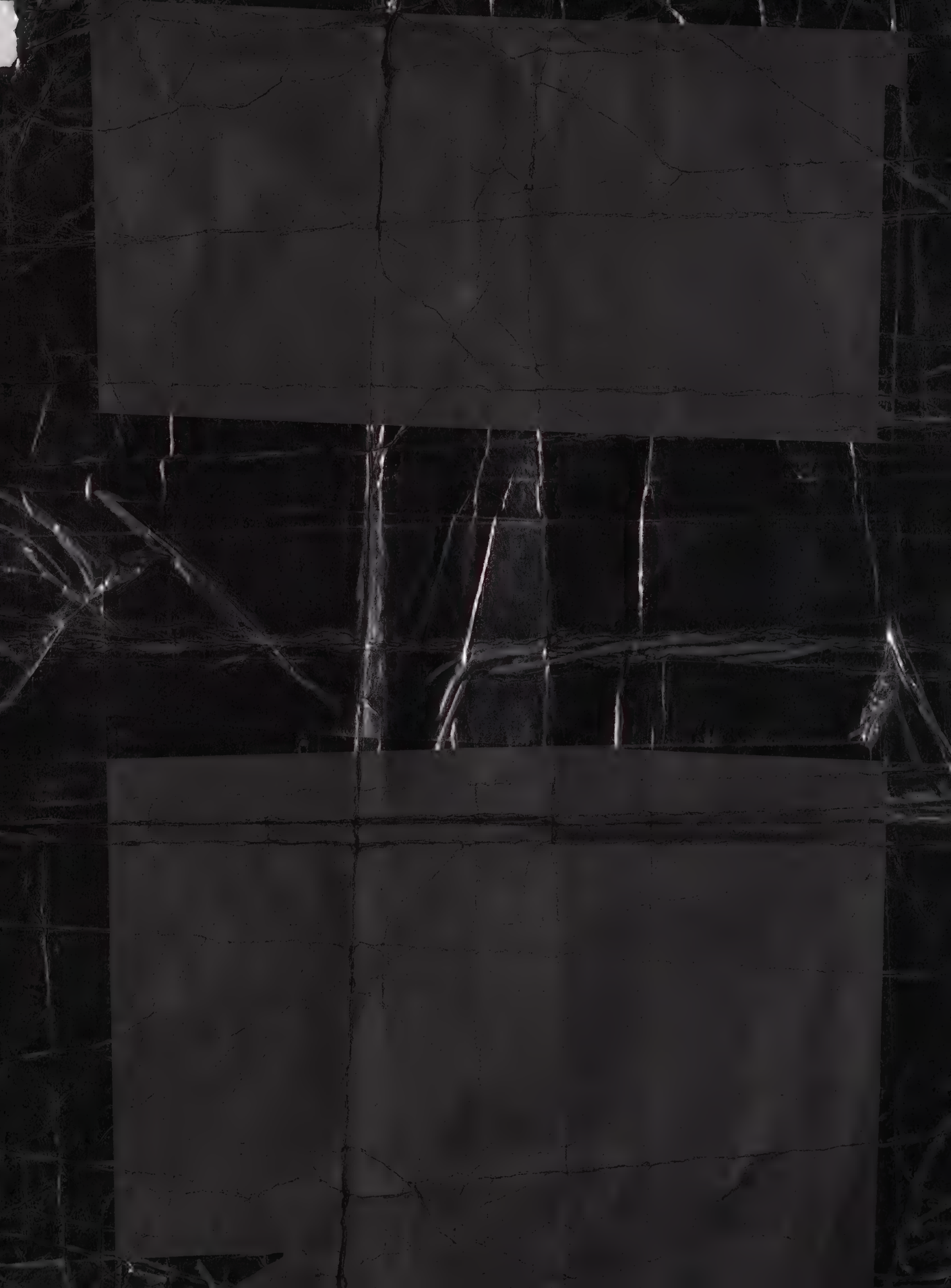
1. Go to the Direct Control screen.
2. Press the "ALL CAPS" key and hold the "E" key down until an entire row of "E's" is displayed.
3. Press the "RETURN" key until the "Z" prompt is positioned at the bottom of the screen.
4. Repeat step 2.
5. Adjust the WIDTH of the display.
   a. Adjust the HORIZONTAL SIZE coil (located inside CRT) until the screen display measures eight inches horizontally.



1. Monitor circuit board
2. Connector (J104)
3. Yoke signal cable (J105)
4. Connector (J106)
5. Connector (J103)
6. Ground cable
7. Horizontal size coil

6. Adjust the HEIGHT of the display.
   a. Turn the HEIGHT pot until the screen display measures six inches.
7. Adjust for equal-size characters on both sides of the screen.
   a. Turn the HORIZONTAL LINEARITY pot until the characters on the left and right side of the screen are the same size.
8. Adjust for equal-sized characters on the top and bottom of the screen.
   a. Turn the VERTICAL LINEARITY pot until the characters at the top and bottom of the screen are the same size.
9. Repeat steps 7 and 8 for the best overall picture linearity.
10. Exit the Direct Control mode.





D. CENTERING THE SCREEN DISPLAY

1. Go to the EDIT PROGRAM screen.
2. Turn the HORIZONTAL CENTERING pot until the vertical line next to the soft keys is 2.25 inches from the edge of the soft keys.

E. ADJUST PICTURE CLARITY

1. Go to the EDIT PROGRAM screen.
2. Adjust the BRIGHTNESS of the picture.
   a. Turn the BRIGHTNESS pot counter-clockwise until the background becomes visible.
   b. Turn the BRIGHTNESS pot clockwise until it just disappears.
3. Adjust the CONTRAST.
   a. Turn the CONTRAST pot until the characters displayed are sharp and clear.
4. FOCUS the screen display.
   a. Turn the FOCUS pot until the images on the screen are sharp and clear.

      Pay particular attention to the characters in the corners of the screen.
5. Repeat steps 3 and 4 for the best overall picture.

F. REASSEMBLE CONTROLLER

1. Turn the Zymate System's power OFF.
2. Turn the Controller's power OFF.
3. Install the sheet metal monitor cover securing with four 6/32 screws.
4. Replace top cover using care to align the plexiglass window in the top channel of the cover.
5. Secure the top cover with the screws.

SPARE PARTS LIST - ROBOT MODULE

P/N	DESCRIPTION	PROC	PM KIT
36073	Arm Assembly	*	
36033	Arm Bearing Assembly		
36039	Bearing 3/4		
36673	Bracket, Power Supply		
36082	Cable, Reach-Long	*	
36081	Cable, Reach-Short	*	
36529	Cable, Rotary-Servo	*	
36085	Cable, Rotary-Long (Fixed End)	*	
36084	Cable, Rotary-Short (Tensioning Screw)	*	
36079	Cable, Vertical-Long	*	
36078	Cable, Vertical-Short	*	
36845	Cable, Communications	*	
36822	Cable, Rotary Electrical		
36784	Cap Pulley Assembly		
36170	Capacitor - 9000 MFD, 25V, .5sp		
36089	Coil Cord Cable	*	*
37483	Coil Cord Guide Assembly	*	
36087	Connector - Cable/Spring		
37460	Coupling - Flexible, Servo	*	*
36873	Cover, PCB Wrist	*	
36337	Diode - Bridge, MDA 800		
36072	Drum - Cable Reach	*	
36065	Drum - Cable Rotary	*	
36070	Drum - Cable Vertical	*	
36318	Drum - Servo Rotary	*	
37452	Epoxy Patch Kit	*	
37282	Flex Circuit Board		
37321	Gear, Antibacklash	*	
37021	Module Interface - Robot		
36492	Motor, Vertical (65.5:1)	*	*
36376	Motor, Reach (19.7:1)	*	*
36818	Motor, Rotary (65.5:1)	*	*
37115	Motor, Wrist	*	*
36939	O-Ring .625 OD		
37335	PC Board, Robot Base (1 pot)	*	
36154	PC Board, Robot Base (3 pot)	*	
36626	PC Board, Base Conn		
37190	PC Board, Wrist	*	
36847	Potentiometer, Reach	*	*
36816	Potentiometer, Rotary	*	*
36817	Potentiometer, Vertical	*	*
37114	Potentiometer, Wrist	*	*
36062	Potentiometer - Servo, 10 Turn		
36850	Power Strip		
36057	Pulley Wheel, Base		
36457	Ring - Retaining		
36706	Shaft - Drive, Rotary Drum	*	
36977	Shaft - Pot Drive, Wrist	*	

SPARE PARTS – ROBOT HANDS

P/N	DESCRIPTION	PROC	PM KIT
37551	Block		
99999	Custom fingers (Std. Tips with Custom Rods)		
99999	Custom Fingers – KOGAN		
99999	Custom Fingers – Tablet Handling Fingers		
37783	Dual Finger Assy (Requires GPH Swap)		
38835	Finger Rod – 4" Blank		
38836	Finger Rod – 6" Blank		
37405	Finger Set (20–25 mm)		
37061	Finger Set (10–12 mm)		
37062	Finger Set (13–18 mm)		
37782	Finger Set – 25mm		
37842	Finger Set 10–12 mm Straight Vertical		
37843	Finger Set 13–18 mm Straight Vertical		
37845	Finger Set 20–25 mm Straight Vertical		
37840	Finger Tips – Rubber, .75" x 2"		
37035	Finger Tips, 10mm–12mm		
37034	Finger Tips, 13mm–16mm		
37182	Finger Tips, 20mm–25mm		
37857	Fingers – Micro Plate Set		
37169	Fingers Adaptor Kit (fabricated by user)		
37788	General Purpose Hand (w/o Fingers)		
36566	Hand Parking Station Kit		
37281	Hand Station Plate		
37552	Rack		
38178	Servo – Modified, GP Hand		
38397	Support – Finger, Straight		
99999	Tensile Test Coupon Fingers		
36016	Z900 General Purpose Hand		
37940	Z900E Corrosion Resistant General Purpose Hand		
38050	Z905 Dual Function Hand		
38411	Pipet Tip Ejector Kit – Syringe Hand		
36597	Pot Assy, Hand		
36551	Servo – Modified		
36863	Syringe – 10ul		
36603	Syringe – 100ul		
36606	Syringe – 1ml		
36600	Syringe – 1ul		
36604	Syringe – 250ul		
36605	Syringe – 500ul		
36602	Syringe – 50ul		
36601	Syringe – 5ul		
36866	Syringe Hand w/o syringe		
37130	Syringe Kit – 1–10ul Syringe to Z910		

Zymate I & II Robot

Section 1: Robot Expoloded Views

Section 2: Theory of Operation

Zymate I and II Robot Theory of Operation

Section 3: Performance

Zymate I/II Robot and Hand Performance Check
Rotary Position Test Procedure
PyRobot Calibration Procedure

Section 4: Troubleshooting

Zymate I Robot Initialization Troubleshooting Guide
Zymate II Robot Initialization Troubleshooting Guide

Section 5: Repair/Replacement

R11 Reach Bearing Adjustment Procedure
R14 Rotary Motor Service Procedure
R20 Vertical Motor Service Procedure
R22 Coil Cord Replacement Procedure
R28 Rotary Servo Cable Replacement Procedure
R33 Reach Potentiometer Service Procedure
R34 Wrist Potentiometer Service Procedure
R37 Wrist Motor Service Procedure
R39 Wrist Replacement Procedure
R40 Reach Bearing and Arm Replacement Procedure
R43 Reach Motor Service Procedure
R46 Wrist Board Replacement Procedure
R55 Vertical Potentiometer Service Procedure
R57 Syringe Hand Adjustment (Model Z910)
R61 Hand Attachment & Parking Procedure
R65 Rotary Drive Cable Replacement Procedure
R71 Anti-backlash Gear Installation Procedure
R76 Robot Baseboard Replacement Procedure
R81 Zymate I Robot Power Supply Adjustments
R87 Rotary Potentiometer Replacement Procedure
R91 Vertical Cable Replacement Procedure
R92 Reach Cable Replacement Procedure
R94 Syringe Change Procedure
R95 GP Hand Adjustment Procedure
R96 Syringe Hand Adjustment Procedure

Section 6: Specifications

Robot Specifications

ROBOT INDEX

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
ARM					
Maintenance	13				
Replacement					R40
BEARINGS					
Proper Alignment					
Reach	2		2		
Rotary	2				
Adjustment					
Reach					R11
Rotary					R87
CABLES					
Proper Tension					
Reach	3				
Rotary Drive	4				

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
Rotary Servo	5				
Vertical	3				
Tension Adjustment					
Reach	3				R92
Rotary Drive	4				R65
Rotary Servo	5				R28
Vertical	3				R91
Replacement					
Reach					R92
Rotary Drive					R65
Rotary Servo					R28
Vertical					R91
COIL CORD					
Cable Replacement					R22
Communication Check		✓	✓		
Guide Installation					R22

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
COMMUNICATION CHECK		✓	✓		
FLEX CIRCUIT					
Communication Check		✓	✓		
GEAR					
Antibacklash, Installation					R71
HANDS					
Alignment with Robot	30				R61
Attachment/Parking	29				R61
General Purpose					
Adjustment					R95
Gain Check	26				R95
Zero Check	25				R95
Precision Syringe					
Adjustment	22				R57, R94,R96

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
Low Volume Adaptor					R94
Gain Check	28				R57, R96
Syringe Replacement					R94
Zero Check	27				R57, R96
INITIALIZATION					
Failure to	8	2	✓		
Common Causes		2	2		
Diagnosing		2	✓		
Localizing to Robot	8	1	2		
Time Duration	8	1	2		
MOTOR					
Current Measurement					
Reach	16				
Rotary	14			10	
Vertical	15				

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
Replacement					
Reach					R43
Rotary					R14
Vertical					R20
Wrist					R37
Rotary Drive Test				14	
PC BOARD					
A/D Converter					
Operations Check		13	✓		
Input Check		11	✓		
Baseboard					
Power Supply Check	10,12	6	✓		R81
Power Supply Adj..	10	6	N/A		R81
Replacement					R76
D/A Converter					
Output Check		9	11		

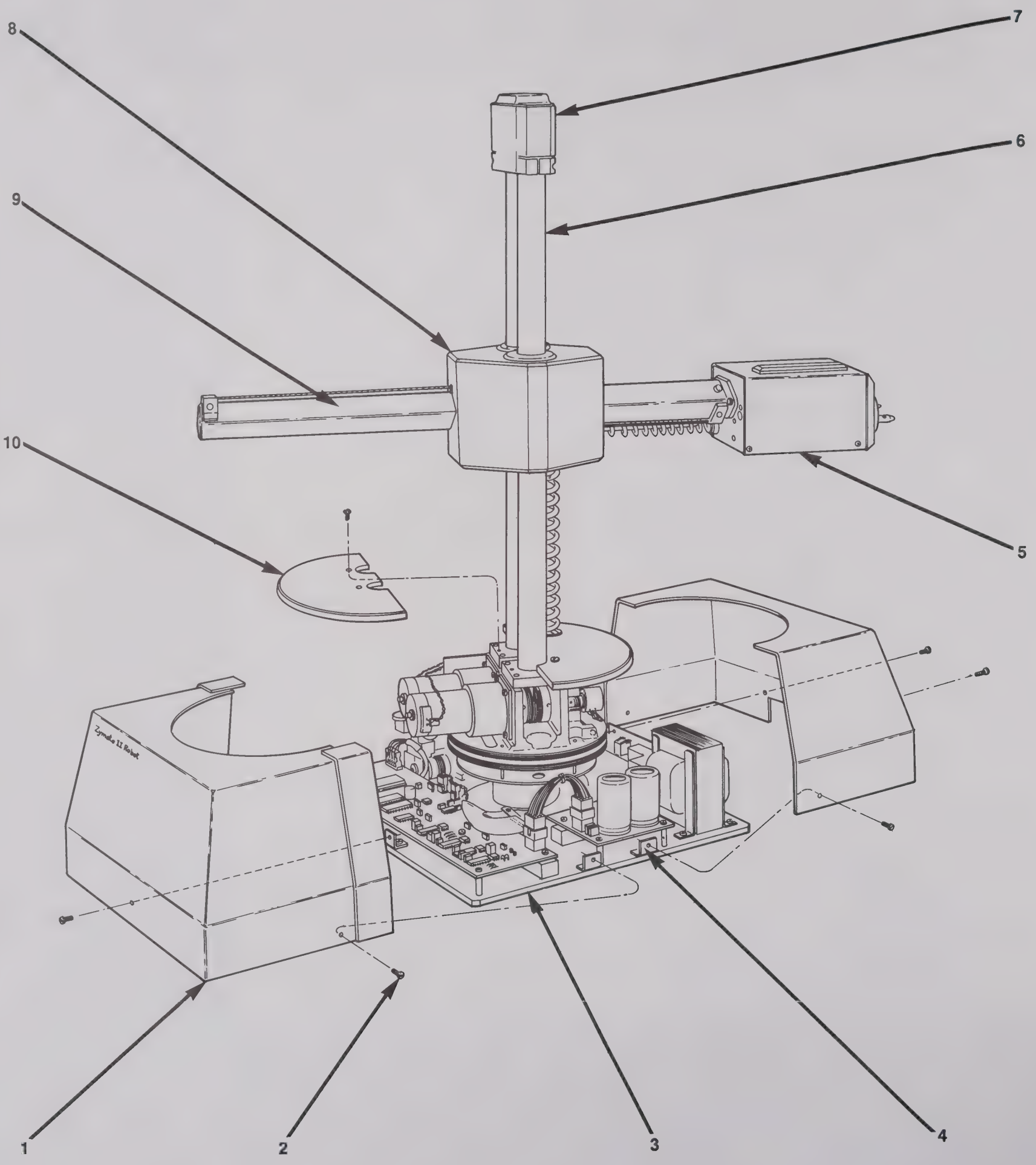
Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
Wrist Board					
Power Supply Check	11,13	7	16		R81
Power Supply Adj	11	7	N/A		R81
Replacement					R46
PERFORMANCE					
GP Hand	25				
Hand Attaching/Parking	29				R61
Operational Integrity	8				
Position Accuracy	18				
Robot Performance	✓				
Rotary Test				✓	
Self Restoring Play	18, 20				
Soft Key Test	18, 19				
Static Check	2				
Syringe Hand	27				

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
POTENTIOMETER					
Adjustment Screw Check	6				
Replacement					
Reach					R33
Rotary					R87
Vertical					R55
Wrist					R34
Smoothness of					
Reach	13				
Vertical	13				
Voltage Check		5	11,15		
POWER SUPPLY					
Voltage Check					
Baseboard	10,12				R81
Wrist	11,13				R81

Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
Voltage Adjustment					
Baseboard	10				R81
Wrist	11				R81
PYCALIBRATION				PyRobot Calibration Proc.	
ROTARY					
Specifications				6	
Test				✓	
Drive Motor				10	
Feedback				11	
WRIST					
Bolts	6			3	
Coupling Alignment	7				R37
Motor					R37
Potentiometer					R34

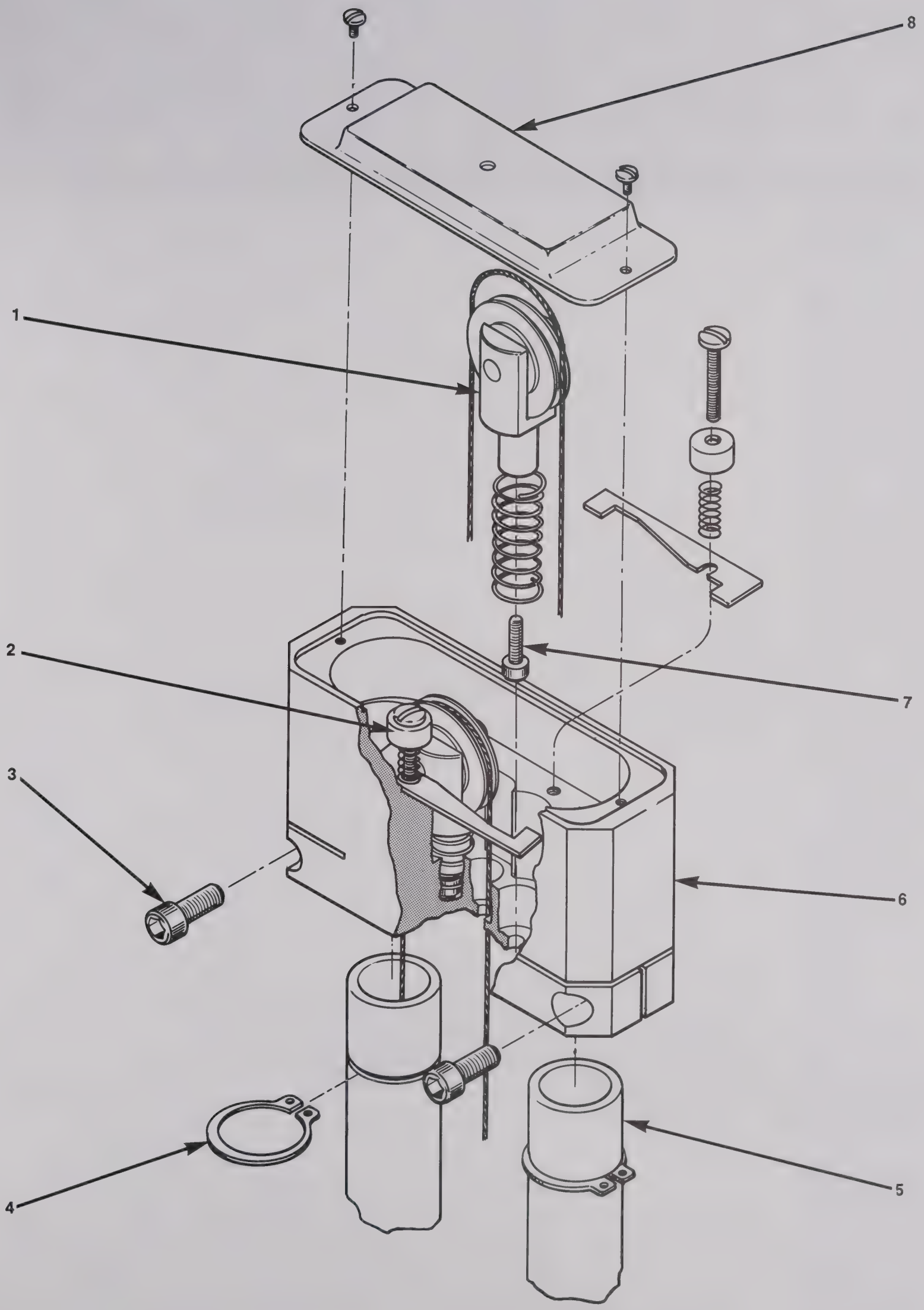
Description	Perform. Check pg. no.	ZY I Init. Guide pg. no.	ZY II Init. Guide pg. no.	Rotary Test pg. no.	Proc. No.
Power Supply Voltage	11,13				R81
Replacement					R39
Test				3	
Zeroing	21				R34

Zymate II Robot



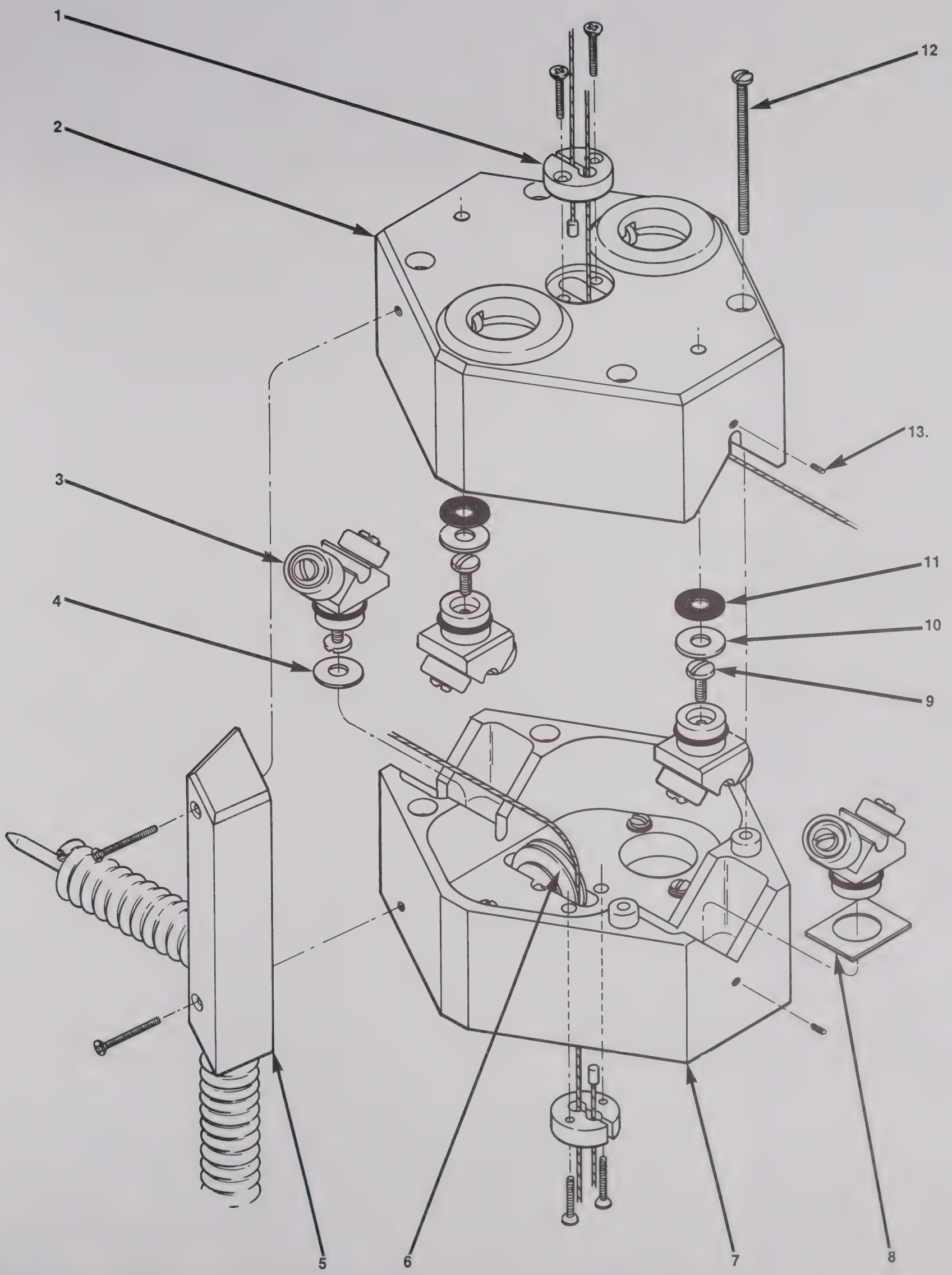
1. Robot skirt(2)
2. Skirt fastener(7)
3. Robot baseplate
4. Skirt bracket(5)
5. Wrist
6. Column(2)
7. Column cap assembly
8. Arm housing
9. Arm
10. Robot cover disk(2)

Column Cap Assembly



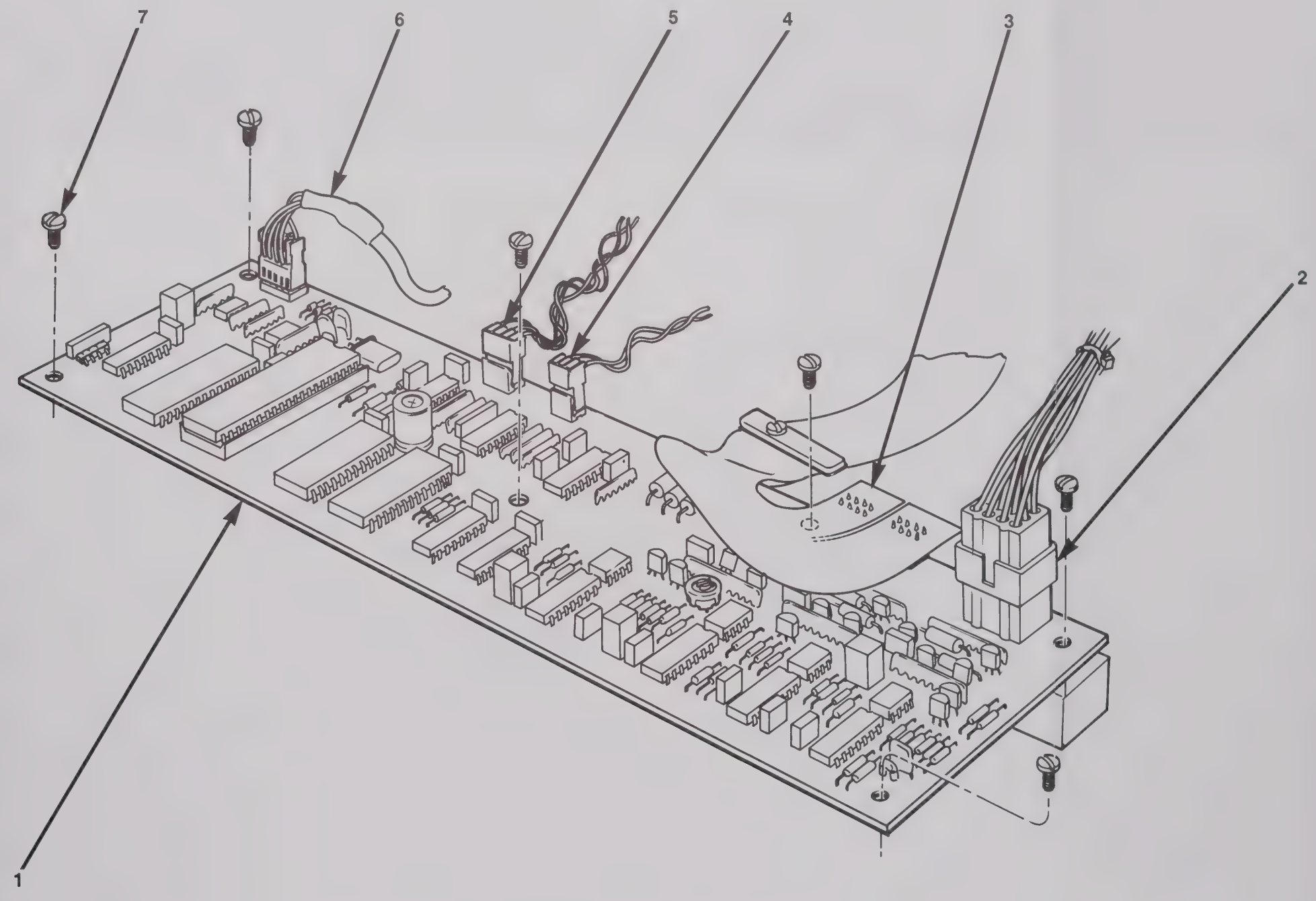
1. Cable pulley assembly(2)
2. Compression screw(2)
3. Column cap assembly fastener(2)
4. Retaining ring(2)
5. Column(2)
6. Column cap assembly
7. Cable tensioning adjustment screw(2)
8. Column cap cover

Arm Housing Assembly



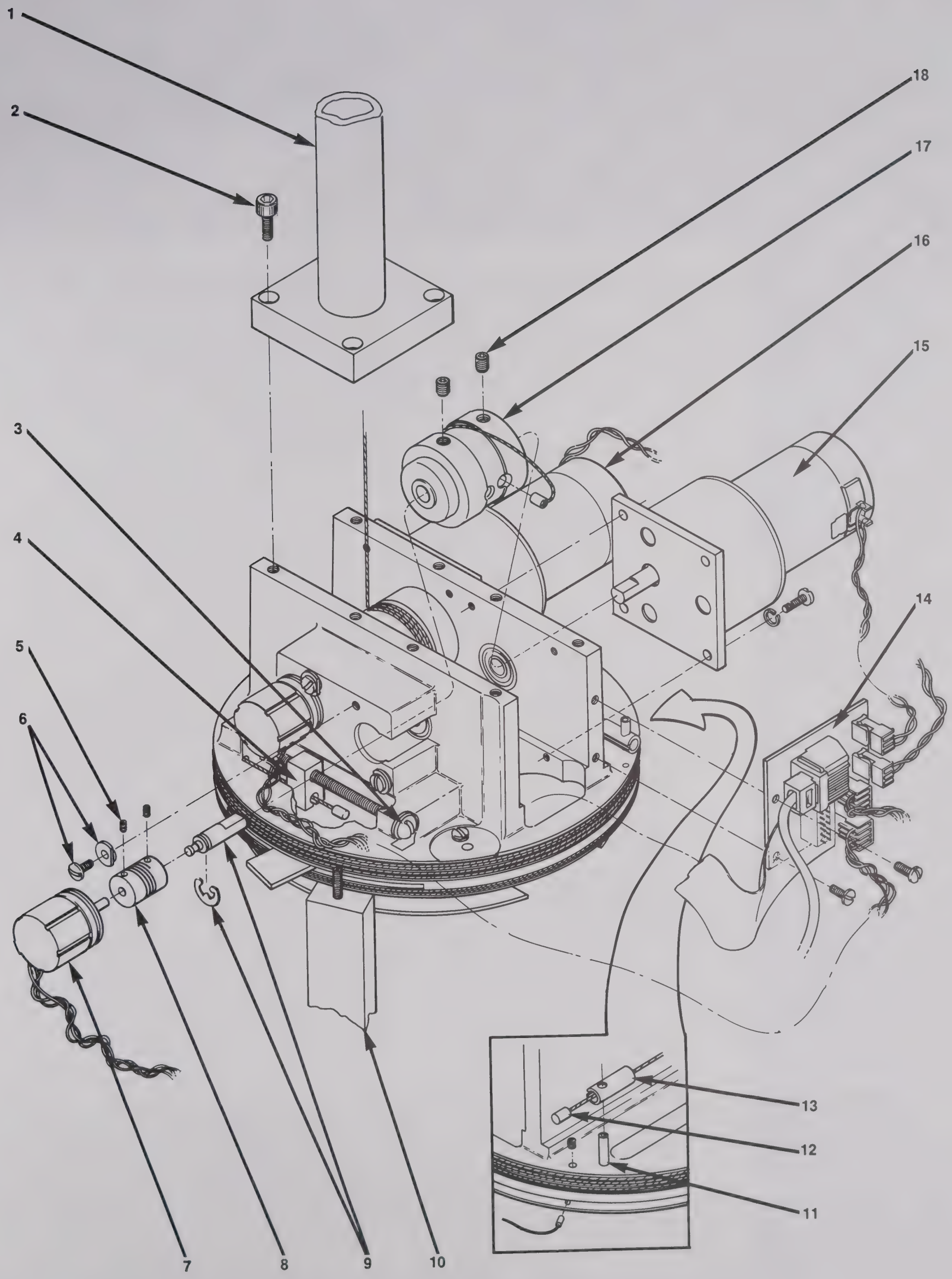
1. Cable retainer (upper)
2. Arm housing (upper half)
3. Reach bearing (3 or 4)
4. Metal washer
5. Cord guide assembly
6. Cable pulley (lower reach)
7. Arm housing (lower half)
8. Shim
9. Reach bearing adjustment screw(2)
10. Metal washer
11. Rubber washer
12. Arm housing screw(4)
13. Reach bearing set screw (4)

Robot Baseboard Assembly



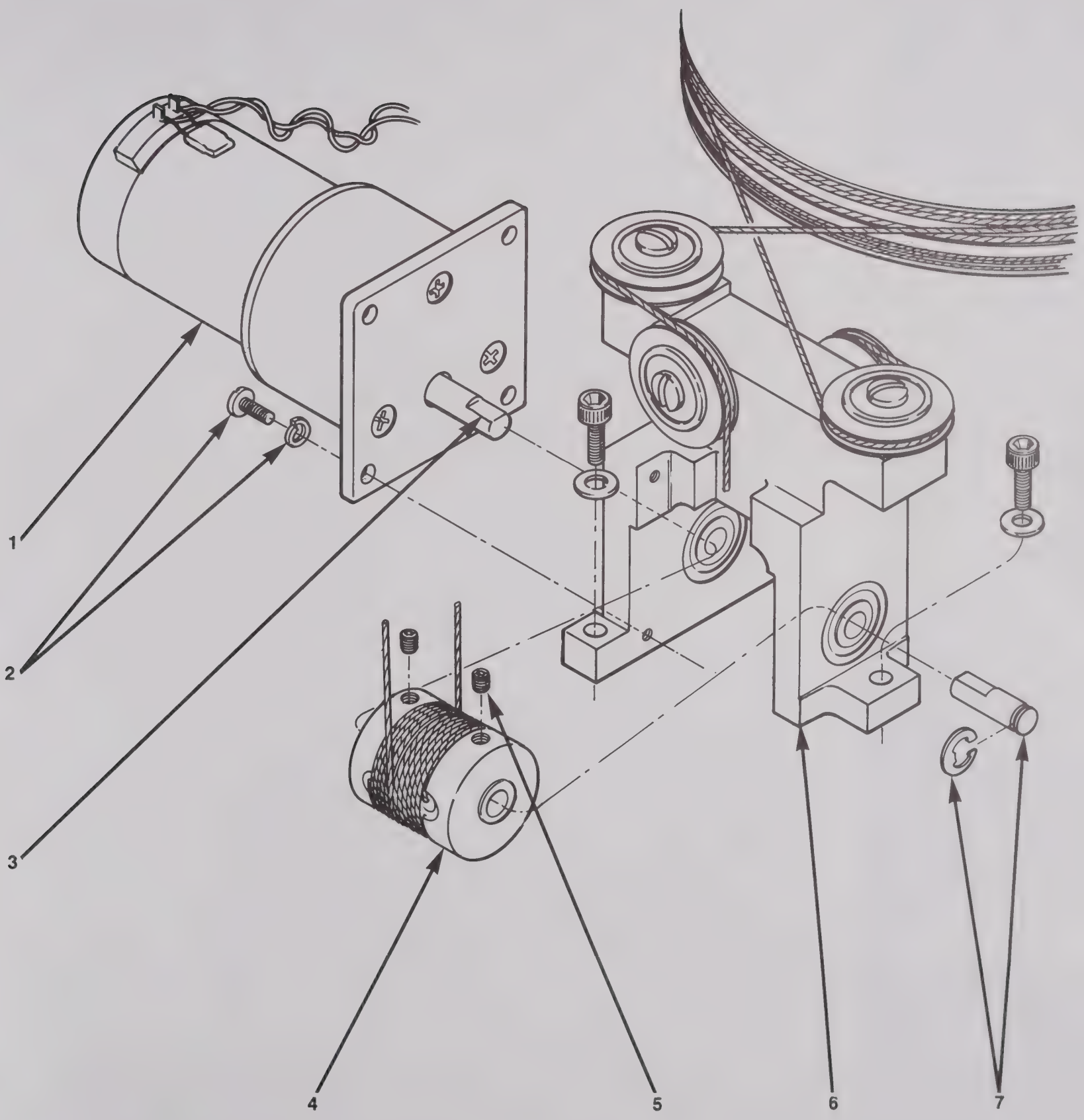
1. Robot baseboard
2. Power supply cable
3. Flex circuit cable
4. Rotary motor cable
5. Rotary potentiometer cable
6. Communication cable
7. Baseboard screw(6)

Turntable and Related Components



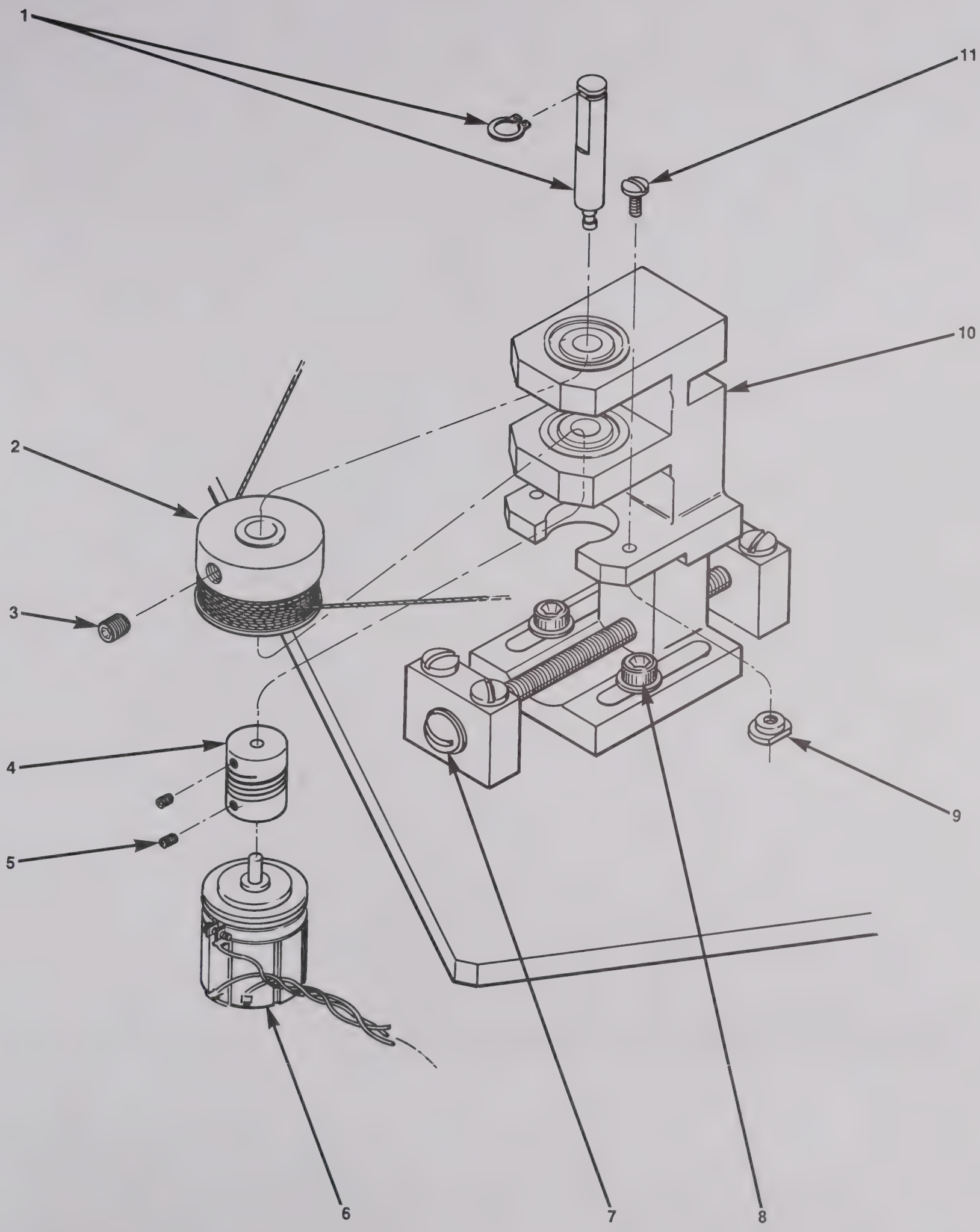
1. Column(2)
2. Column fastener(8)
3. Rotary cable tensioning screw
4. Tension adaptor block
5. Set screw(2)
6. Cleat with adjustment screw(2)
7. Vertical potentiometer
8. Flex coupling
9. Flex coupling shaft with retaining ring
10. Rotary stop block
11. Roll pin post
12. Rotary cable
13. Spring cable connector
14. Interconnection board
15. Vertical motor
16. Reach motor
17. Vertical drum
18. Set screw(2)

Rotary Drive Assembly



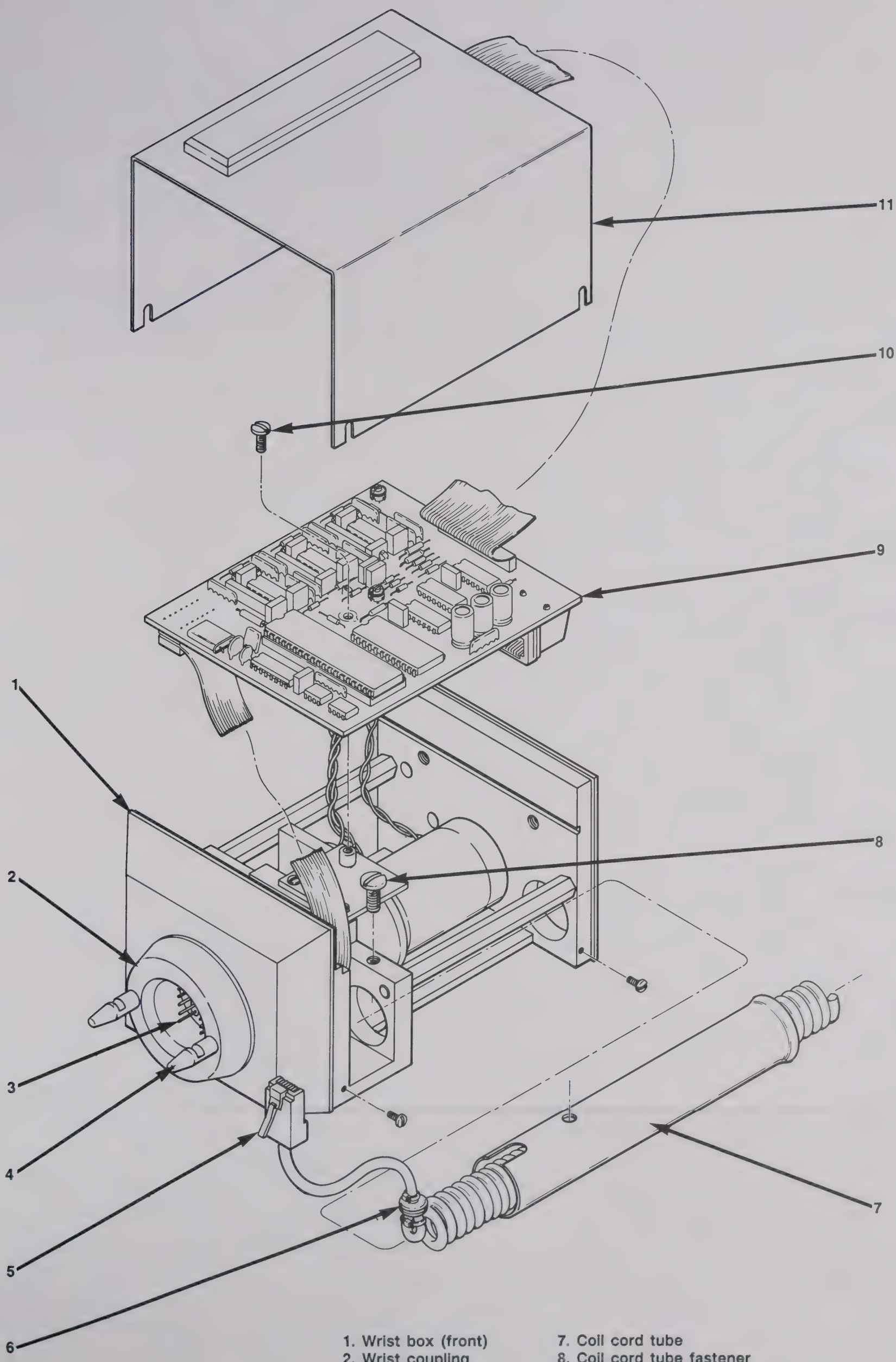
1. Rotary motor
2. Mounting screw and washer (4)
3. Rotary motor shaft
4. Rotary drive drum
5. Set screw(2)
6. Pulley mount assembly
7. Rotary drive drum shaft with retaining ring

Rotary Servo Assembly



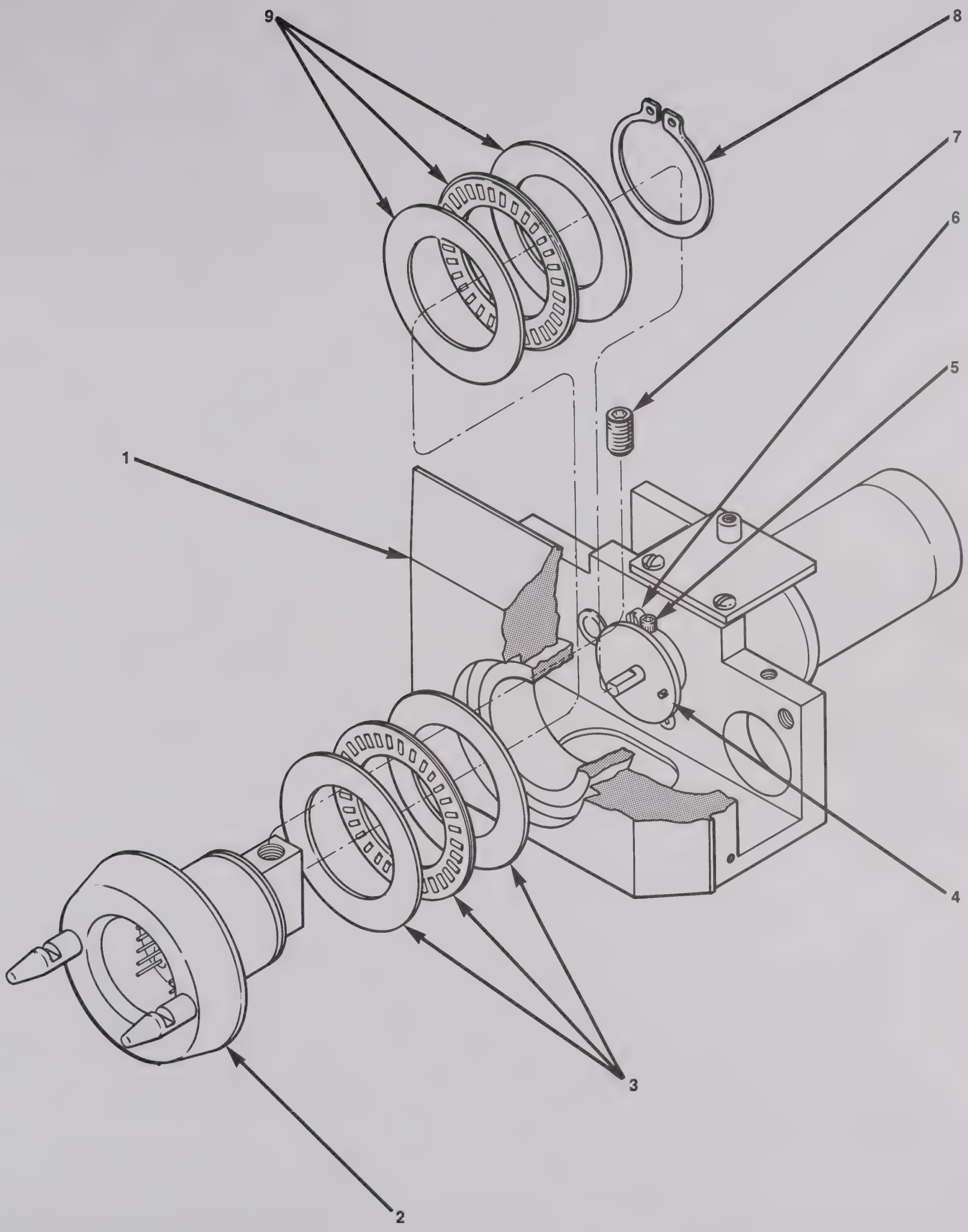
1. Rotary servo drum shaft with retaining ring
2. Rotary servo drum
3. Set screw
4. Flex coupling
5. Set screw(2)
6. Rotary position potentiometer
7. Rotary servo cable adjustment screw
8. Rotary pot assembly allen head(2)
9. Cleat(2)
10. Rotary pot assembly
11. Rotary pot adjustment screw (2)

Wrist Assembly



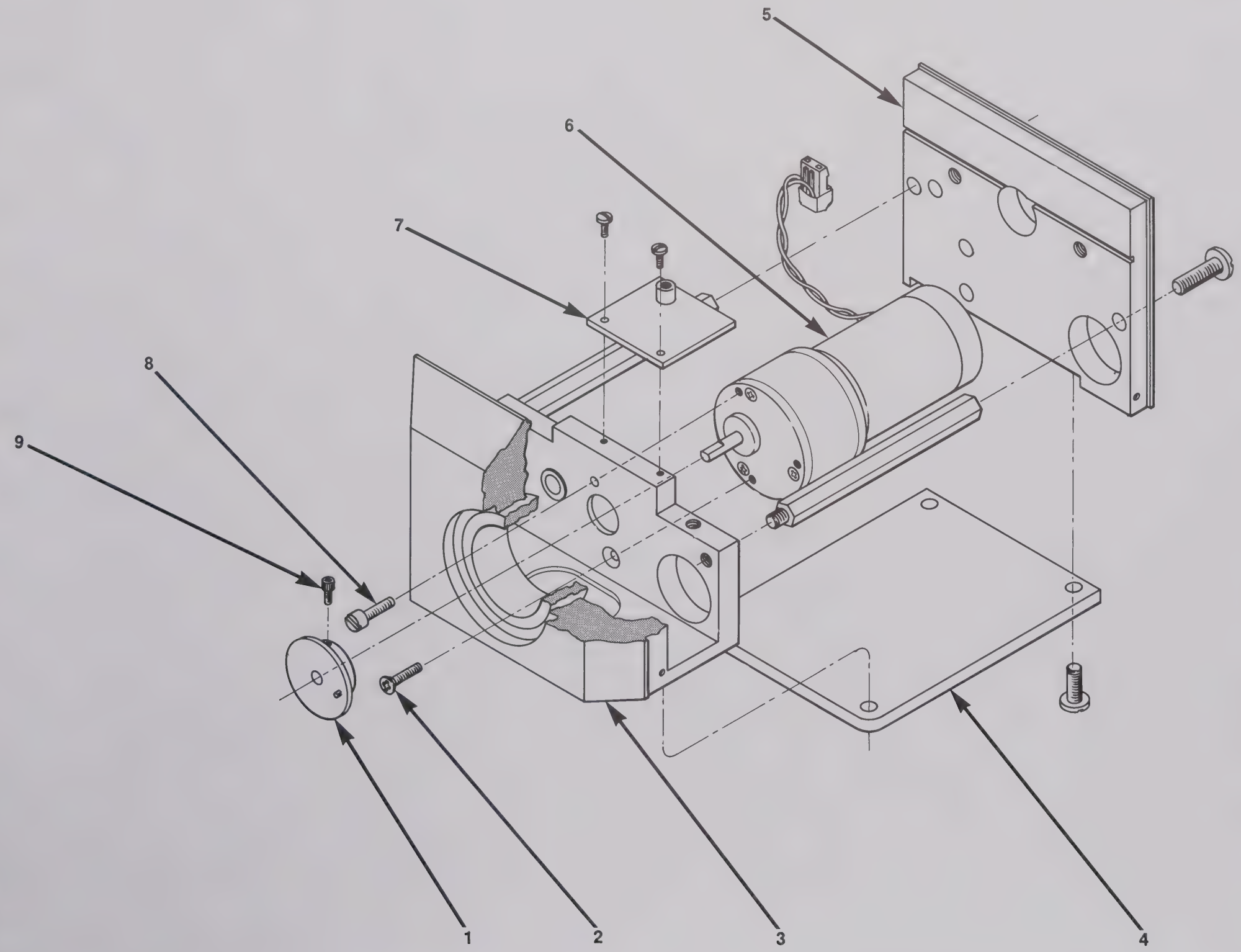
1. Wrist box (front)
2. Wrist coupling
3. Wrist pin (electrical)
4. Wrist pin(2)
5. Coil cord
6. Rubber grommet
7. Coil cord tube
8. Coil cord tube fastener
9. Wrist PCB
10. Wrist PCB center screw
11. Wrist box cover

Wrist Box Assembly (front)



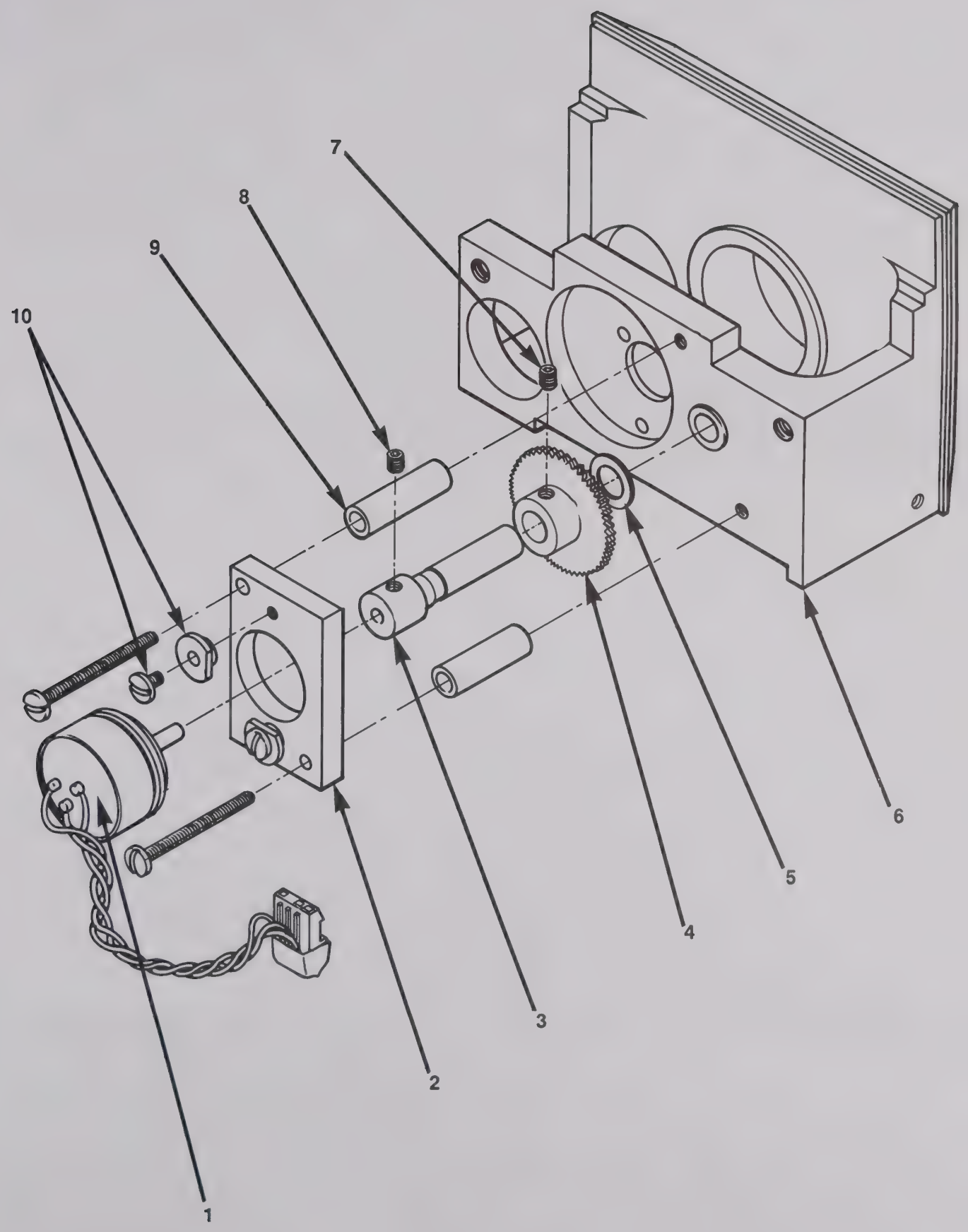
1. Wrist box (front)
2. Wrist coupling
3. Bearing and races (outer)
4. Wrist stop idler wheel
5. Wrist stop socket head
6. Wrist stop pin
7. Motor shaft set screw
8. Snap ring
9. Bearing and races (inner)

Wrist Box Assembly



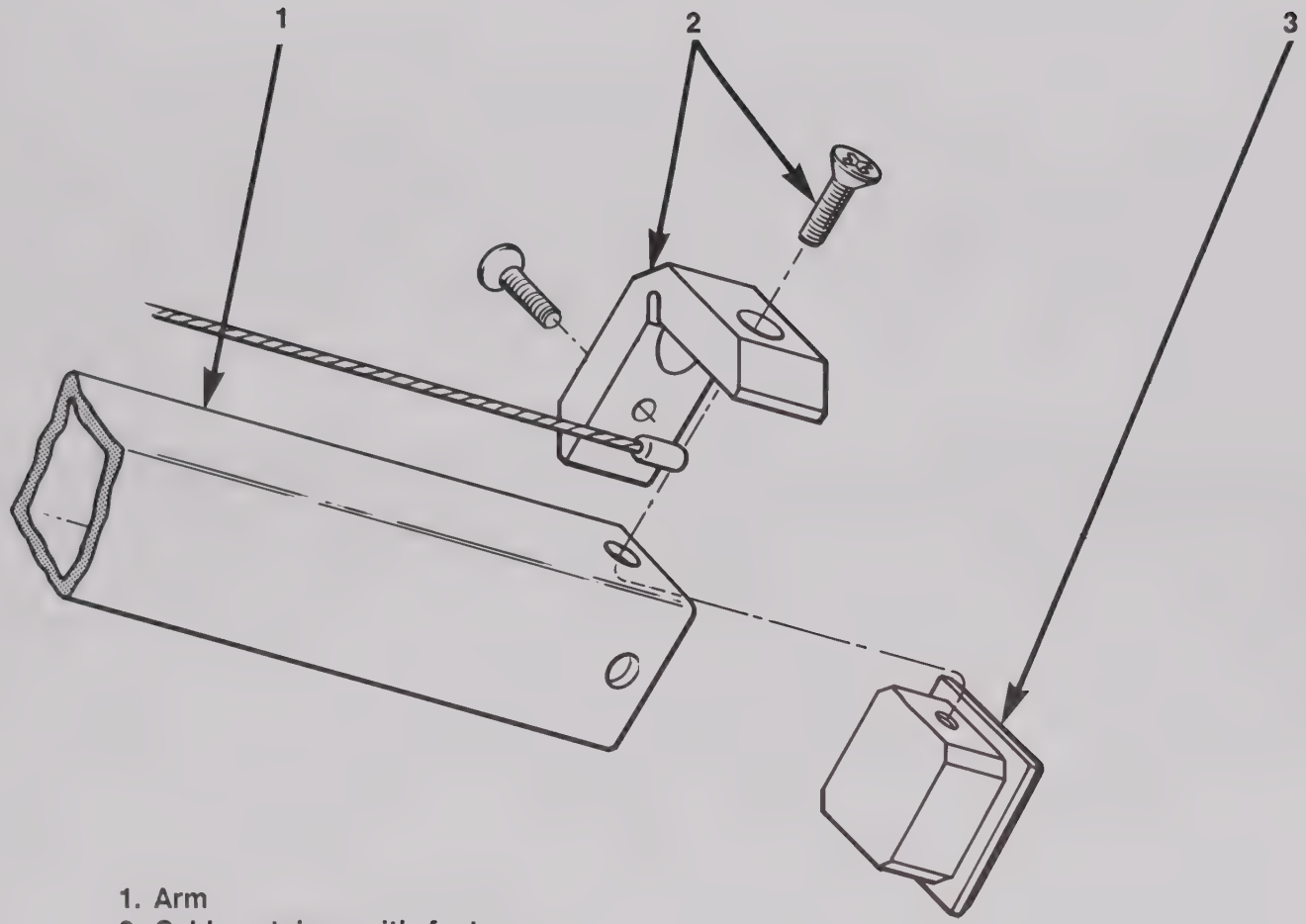
1. Wrist stop idler wheel
2. Motor fastener (lower)
3. Wrist box (front)
4. Wrist box (base)
5. Wrist box (rear)
6. Wrist motor
7. Wrist board support plate
8. Wrist stop pin
9. Wrist stop socket head

Wrist Potentiometer/Wrist Box Assembly



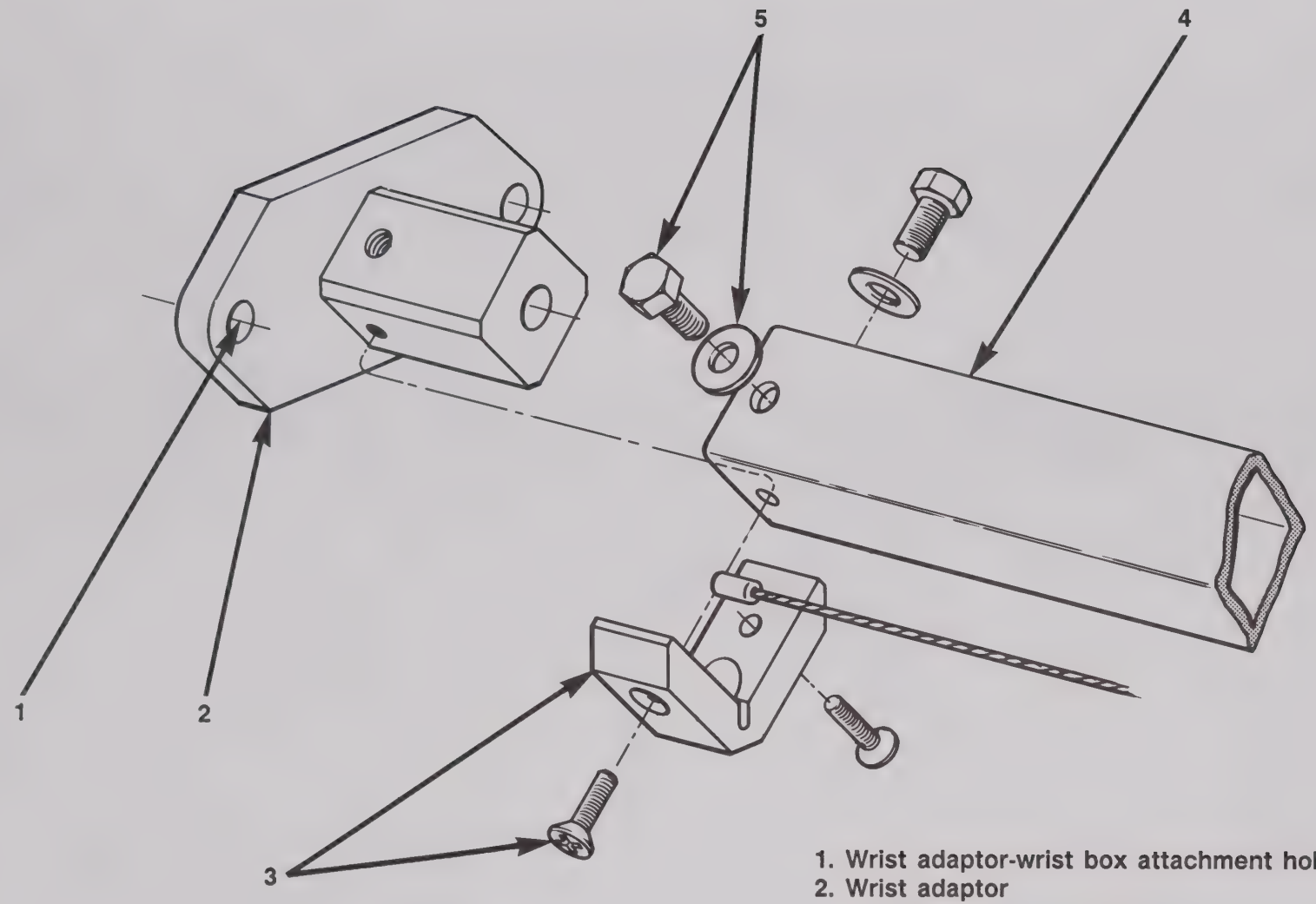
1. Wrist potentiometer
2. Pot mounting plate
3. Pot drive shaft
4. Anti-backlash gear and hub assembly
5. Brass washer
6. Wrist box (front)
7. Set screw (anti-backlash gear)
8. Set screw (drive shaft)
9. Standoff(2)
10. Cleat with adjustment screw(2)

Robot Arm (elbow)



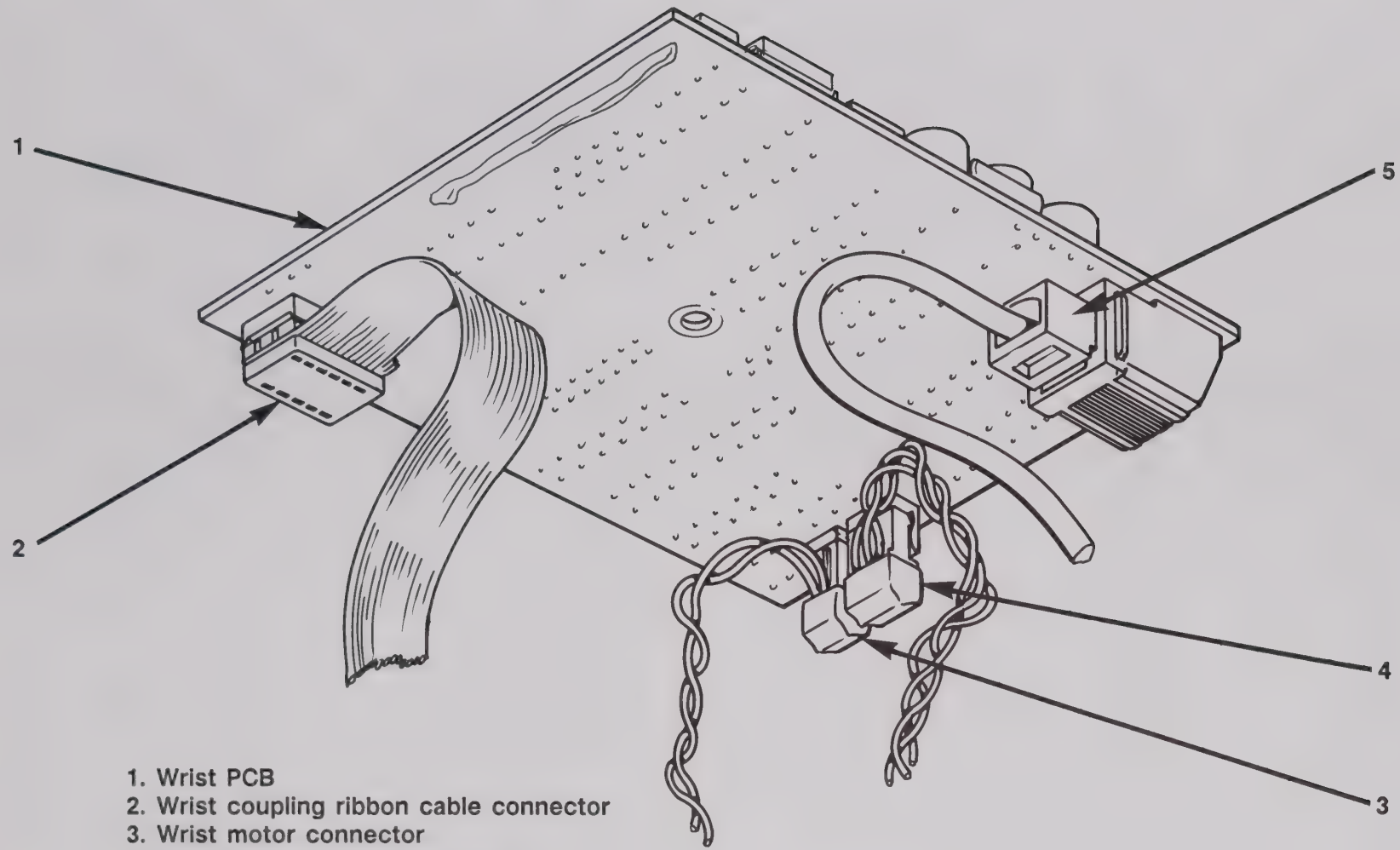
1. Arm
2. Cable retainer with fastener
3. End plug

Robot Arm (wrist end)



1. Wrist adaptor-wrist box attachment holes(2)
2. Wrist adaptor
3. Cable retainer with fastener
4. Arm
5. Arm–wrist adaptor bolt and washer(2)

Wrist PCB (bottom)



1. Wrist PCB
2. Wrist coupling ribbon cable connector
3. Wrist motor connector
4. Wrist potentiometer connector
5. Communication cable connector

ZYMATE I AND II
ROBOT MODULE THEORY OF OPERATION

INTRODUCTION

The Robot is a module of the Zymate System used to physically transfer containers such as vials, test tubes and other vessels from station to station during sample preparation. The robotic arm connects to a variety of general purpose and specialized hands through its multifunction wrist.

The base and wrist have separate microprocessor controls and function independently. The Robot's base controls all three base-axis functions: (1) 0 to 376 degrees of rotary movement (2) 0 to 34 cm of vertical movement (3) 0 to 32cm of reach movement. The Robot's wrist controls all three hand functions: (1) -5 to 365 degrees of wrist rotation for Zymate II Robots; 0 to 360 degrees for Zymate I Robots (2) finger opening and closing from 0-200 units (3) syringe opening and closing from 0-200 units. The Robot's arm can be positioned to any point in a cylindrical space that is within its range of movement. The arm's location at any time is represented by a set of vertical, reach and rotary coordinates. Hand movements are similarly commanded, with the respective values for wrist angle, grip position and syringe position represented within the system.

ARM MOTION

The Robot's arm movements are controlled by three servo motors. The reach, vertical and rotary positions are constantly tracked by the Robot electronics. Tracking occurs by reading voltages from potentiometers which are mechanically connected to the three axes. These potentiometer voltages are proportional to the actual position of their axis. A command to go to a Robot position generates particular location voltages, which are compared with the potentiometer voltages (actual positions). The error amplifiers that compare these voltages generate error voltage differences that are proportional to the Robot's positional errors. The error voltages are fed into motor-driver amplifiers which drive the servo-motors in directions that reduce the positional errors. Once the potentiometer voltages match their respective location voltages, the motors stop and correct positioning exists.

REACH MOTION

The reach displacement of the robotic arm, described in terms of IN/OUT travel, is from 0 to 32cm. Because the reach servo motor only controls this IN/OUT motion, and is never required to lift weight, it has the highest speed of the three Robot motors. However, since the UP/DOWN motion of the arm shortens or extends the reach cable, the reach servo is required to track vertical movement to maintain the desired reach position. Since the servo motors do not operate until an error is seen, there may be a slight, inherent reach error during UP/DOWN motion that is corrected when the desired height is attained.

VERTICAL MOTION

The vertical displacement of the robotic arm, described in terms of UP/DOWN travel, is from 0 to 34 cm. During upward movement, the vertical servo motor must overcome the weight of the arm, hand and any load that may be attached. This results in a quick stop when the desired vertical height is reached. In order for the Robot to accurately locate a vertical position in a downward move without overshooting, the Robot must gradually slow to a stop as it nears the desired position.

ROTARY MOTION

The rotary capability of the robotic arm, described in terms of CLOCKWISE/COUNTER CLOCKWISE travel, is from 0 to 376 degrees. The rotary servo has the accuracy to resolve the desired angular location to within 1 mm over a distance of 15 feet. This servo must also overcome inertia (particularly at full reach) when moving to a rotary destination.

ROBOT INITIALIZATION

Robot initialization is the process used by software on the Robot's Module Board to determine the position of the Robot's axes. Initialization occurs each time the Controller is turned on. Systematic search signals are compared with the three axes' potentiometer values to determine axis positions. During this time, the Robot's motors are temporarily disabled by the Robot's electronics. Once the errors between the search signals and the potentiometers reach a specified minimum, the motors are re-enabled and initialization is complete. The Robot arm may exhibit a slight "jump" when the drive motors are enabled.

For Zymate I Robots, there is no initialization process for the wrist. Instead, the wrist will automatically rotate to the zero position and the syringe and grip will seek their mid-range, 100 unit positions.

For Zymate II Robots, the wrist initialization process depends upon the power status of the Robot prior to powering up the Controller. If the Robot was on and previously initialized, then a power cycle on the Controller results in maintaining existing wrist conditions. If Robot power was off, the normal sequence of powering on the Robot, immediately followed by a Controller power cycle, results in a wrist initialization routine taking place, with the wrist seeking its zero position.

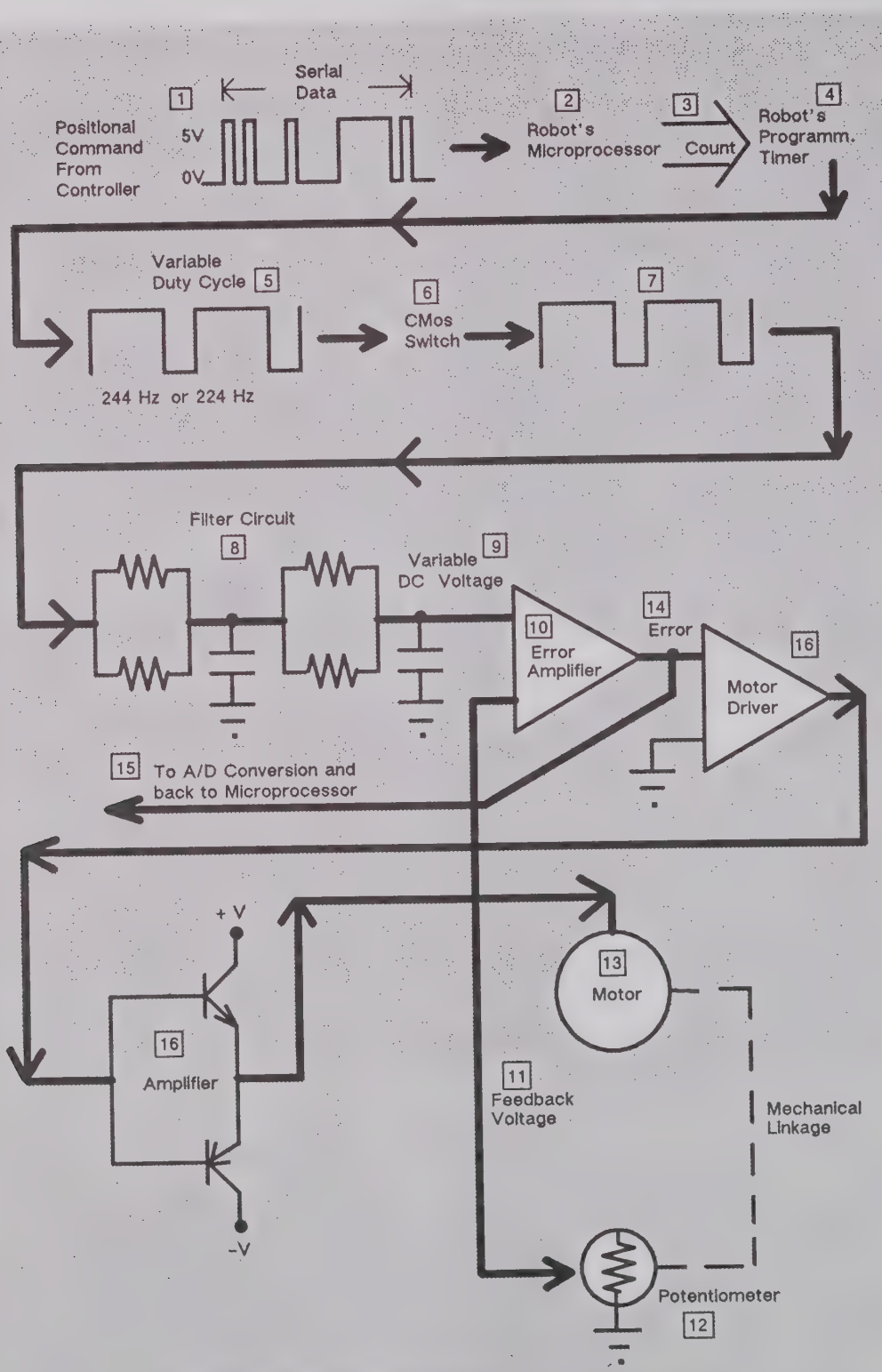
COMMAND COMMUNICATION

Positional commands from the Controller are translated by the Robot Module Board and then sent to the Robot base and wrist for execution. This serial communication link utilizes intensive, bi-directional error detection, with no command execution until correct data reception is confirmed. The base and wrist accept data from the Module Board only when their unique address has been transmitted. Data transmitted from the base and wrist to the Controller is gated in a manner that combines base and wrist data onto one common transmit line. These features allow the base and wrist to share common transmit and receive lines without problems of contention.

POSITIONAL COMMAND SIGNAL FLOW

The description below follows the signal flow and tracking required by the Robot to execute a move to a desired axis location. The numbers within the text refer to the diagram on the following page.

A positional command generated at the Controller [1] and translated by the Robot's module board, is sent to the Robot's microprocessor [2] via the serial data link. This data is converted into a parallel count [3] and fed into the Robot's programmable timer [4]. The programmable timer generates a fixed frequency, variable duty cycle output [5] based upon the value of the count. From the timer, the signal is fed into a CMOS switch [6] which forms the digital highs and lows of the timer into precision, analog highs and lows [7]. These signals are sent to the filter circuit [8] to be time-averaged into a variable voltage, dc level set point [9] that corresponds to the originally generated positional command. This set point is presented to an error amplifier [10] which compares the set-point value with the feedback value [11] from the potentiometer [12] directly connected to the motor [13] for the axis to be driven. The difference (error) [14] between these two values drives the motor in a direction that reduces the error (thereby changing the pot voltage to match that of the set-point voltage). The error is also fed back to the Robot's microprocessor through an analog to digital circuit [15], where it is periodically monitored by the microprocessor. Correct positioning exists when the error value falls within a specified window. The error voltage drives the axis motor by passing through a motor/driver amplifier circuit [16] providing the necessary power to the motor.



Controller / Robot Signal Flow Diagram

ZYMATE I/II ROBOT and HAND PERFORMANCE CHECK

TOOLS REQUIRED:

Screwdriver, blade 1/8 x 4, 3/16 x 6, 1/4 x 6
Screwdriver, Phillips, #1, #2
Wrench, hex (Allen), .050, 3/32, 9/64, 3/16
Wrench, open-end, 5/16
Rule, steel, 12", 18" (0.1 increments)
Digital Voltmeter (DVM)
Hex driver, ball-end, 9/64

PROCEDURE SCOPE:

The following performance checks may be used to verify that the module IS or IS NOT functioning properly.

This performance check is arranged in three sections:

1. STATIC CHECK

   Done with the Robot's power off. Confirms STRUCTURAL integrity.

2. DYNAMIC CHECK

   Done with the Zymate Controller's power ON. Confirms OPERATIONAL integrity and ACCURACY.

3. DYNAMIC PERFORMANCE

   Done with the Zymate Controller's power ON. Confirms operation and accuracy of Robot servo-mechanisms.

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Troubleshooting and parts replacement procedures are provided in this chapter of the Service Manual.

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: STATIC CHECK

TURN THE CONTROLLER'S POWER OFF.
TURN THE ROBOT'S POWER OFF.

The static Robot check determines the STRUCTURAL INTEGRITY of the Robot.

A. BEARINGS – VERIFY PROPER ALIGNMENT

1. ROTARY

a. Grasp the column cap.

b. Using moderate force, rock the Robot's rotating structure sideways at angles parallel to the arm.

_____c. Verify there is no bearing freeplay.

CORRECTIVE ACTION **Rotary bearing adjustment requires substantial disassembly of the Robot and, if required, should be done by Zymark service personnel.**

2. REACH

a. Using moderate force, rock the arm vertically.

_____b. Verify there is no vertical freeplay where the arm enters the arm housing.

CORRECTIVE ACTION **The reach bearings are adjusted with a small blade screwdriver through two holes in the top of the arm housing. On Robots built after 6/88, it is necessary to first loosen the four set screws that secure the reach bearings in place. Two are located on the arm housing just above and below the point where the arm exits from the front of the housing. The other two are located exactly 180 degrees opposite, at the point where the arm exits the rear of the housing. Using the .050 Allen wrench, loosen each set screw approximately 2 turns. Then, turn each reach adjustment screw COUNTER CLOCKWISE until tight. Next, turn the screws CLOCKWISE 1/16 turn. Finally, if applicable, retighten the four set screws.**

Refer to R11 REACH BEARING ADJUSTMENT for more detailed information.

B. CABLE TENSION

- It is good practice to establish a "feel" for normal cable tension so that abnormal conditions can be promptly detected. Periodic checking of cable tension can detect a gradual deterioration of performance at an early stage.
- After extensive use it MAY become necessary to retension the cables. This is because the nylon cable jacket flattens slightly as it is repeatedly worked over the pulleys and drums.
- If a cable is replaced for any reason, its tension should be checked after 24–48 hours of operation.

1. REACH CABLE

The reach cable is the cable that passes through the HOLE in the cable retainer in the top of the arm housing.

a. Position the arm at mid–height.

b. Grasp the cable (vertical section) at mid–length and pull it sideways.

_____c. A force of approximately 2 lbs. should move the center of the cable .20 to .25 inch (.5 to .6 cm).

CORRECTIVE ACTION **The cable can be adjusted with a 9/64 ball-end hex driver through the left-most hole in the bottom side of the column cap. (As viewed from the wrist–end of the arm).**

Note that CLOCKWISE is relative to the end of the screwdriver's handle.

1. **Turn the screw CLOCKWISE several turns to fully disengage it.**
2. **Turn the screw COUNTER CLOCKWISE until a slight resistance is felt.**
3. **Continue to turn COUNTER CLOCKWISE one more turn.**

Refer to R92 REACH CABLE REPLACEMENT PROCEDURE for more detailed information.

2. VERTICAL CABLE

The vertical cable is the one that passes through the SLOT in the cable retainer in the top of the arm housing.

a. Position the arm at mid-height.

b. Remove any hand that may be attached.

c. Grasp the cable at mid-length and pull it sideways.

_____d. A force of approximately 2 lbs. should move the center of the cable .20 to .25 inch (.5 to .6 cm).

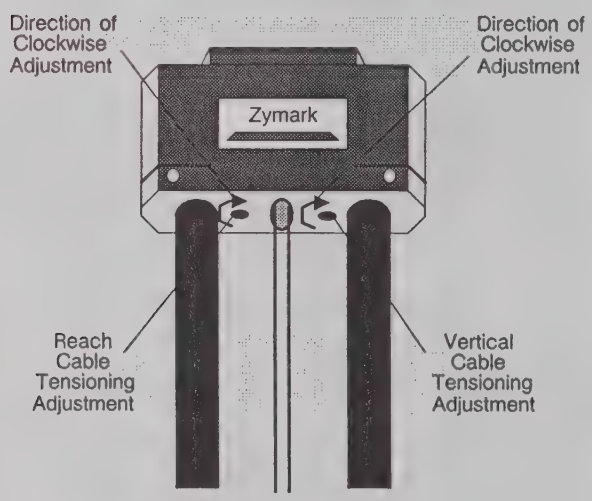
CORRECTIVE ACTION

The cable tension can be adjusted with a 9/64 ball-end hex driver through the right-most hole in the bottom of the column cap. (As viewed from the wrist end of the arm.

CLOCKWISE is relative to the end of the screwdriver's handle.

1. **Turn the screw CLOCKWISE several turns to fully disengage it.**
2. **Turn the screw COUNTER CLOCKWISE until a slight resistance is felt.**
3. **Continue to turn COUNTER CLOCKWISE one more turn.**

Refer to R91 VERTICAL CABLE REPLACEMENT PROCEDURE for more detailed information.



3. ROTARY DRIVE CABLE

The ROTARY DRIVE CABLE is the thicker of the two cables wound around the turntable.

a. Remove the Robot skirts.

b. Grasp the longer of the cable sections between the turntable and motor drive assembly and pull the cable sideways.

_____c. A force of approximately 2 lbs. should move the cable .04 to .08 inch (.1 to .2 cm).

CORRECTIVE ACTION

It is important to distribute the change in cable tension over the WHOLE cable when making any cable tension adjustment. Failure to do this can result in breaking the adjustment end of the drive cable.

The rotary drive cable tension adjustment is the long screw just below the vertical and reach pots on the turntable.

1. **Keep the drive drum from turning when adjusting cable tension by inserting an Allen wrench into the drum's left set screw.**
2. **Move the arm to maximum reach and push the wrist box in a CLOCKWISE direction using approximately 5 lbs. of force.**

   The Allen wrench should move towards the skirt bracket and stop further drum rotation.
3. **Tighten the rotary cable tensioning screw (CLOCKWISE) while pushing on the wrist box to remove visible cable slack.**
4. **Push the wrist box from side to side to alternately tension and relax each of the two drive cable sections.**
5. **Remove the Allen wrench.**

Refer to R65 ROTARY DRIVE CABLE REPLACEMENT PROCEDURE for more detailed information.

4. ROTARY SERVO CABLE

The ROTARY SERVO cable is the thinner of the two cables wound around the turntable.

a. Remove the Robot skirts.

b. Grasp either section of the cable between the turntable and the rotary pot assembly and pull the cable sideways.

_____c. A force of approximately 2 lbs. should move the cable .15 to .20 inch (.4 to .5 cm).

CORRECTIVE ACTION

Adjustment of the rotary servo cable tension involves moving the rotary pot assembly away from, or toward the turntable.

1. **Loosen the two Allen head screws that secure the pot assembly to the baseplate.**

   Leave each of these screws just tight enough to permit the asssembly to slide on the baseplate, but still tight enough so that the assembly doesn't tip towards the turntable.

2. **Turn the long adjustment screw that runs through the base of the assembly to adjust the rotary servo cable tension.**

3. **After adjustment is made, retighten the two mounting screws.**

4. **Tightening of the mounting screws may further increase cable tension. Check cable tension after the screws are tightened, and readjust as necessary.**

Refer to R28 ROTARY SERVO CABLE REPLACEMENT PROCEDURE for more detailed information.

C. POTENTIOMETER ADJUSTMENT SCREWS

_____Check that the two screws that secure the body of each of the three axis position feedback pots are just snug and not overtightened.

CORRECTIVE ACTION

If over-tightened, the screw may damage the pot flange. The screw only needs to be tight enough to keep the pot from turning.

D. WRIST BOLTS (Only required for Robots received prior to 9/83)

_____Check that the bolts securing the wrist box to the arm are tight.

CORRECTIVE ACTION

Repeated loosening of wrist bolts can be permanently fixed by Zymark service personnel.

or,

Refer to R40 ARM REPLACEMENT PROCEDURE for instruction on how to attach the wrist box to the arm.

E. WRIST COUPLING

1. SQUARE WITH THE BENCH:

   a. Move the arm near a hand parking station.

   _____b. Using a square, check that the face of the wrist coupling is vertical with the benchtop to within .002 inch (.05mm).

   - Use a piece of paper as a feeler gauge between the square and the top and bottom of the wrist coupling. The paper should not fit between the square and wrist coupling.

   c. Repeat steps a and b at several other places on the benchtop to isolate the problem to the wrist coupling or an uneven benchtop.

   CORRECTIVE ACTION **If necessary, the wrist box can be shimmed at the top or bottom of its wrist adaptor to position the wrist coupling face perpendicular to the benchtop.**

> *Note: Do not attempt to shim Py-section Robots. Contact Zymark service for assistance.*

2. CHECK SET SCREW:

   a. Manually rotate the wrist coupling with moderate force in both directions.

   _____b. Verify that there is only a small amount of freeplay.

   _____c. Verify that the wrist coupling is not slipping or loose on the motor shaft.

   - Make sure that the slippage is not mistaken for actual turning of the motor shaft.

   _____d. Verify that the Phillips screws in the hand mounting cavity are tight.

   CORRECTIVE ACTION **To tighten the wrist set screw it is necessary to remove the wrist box cover, unfasten and push the wrist board to one side, and move the ribbon cable forward to get to the set screw in the block on the motor shaft.**

   Loctite 222® is used at the factory to secure the set screw. Reapply Loctite 222® to set screws that frequently come loose. In extreme cases, it may be necessary to replace the set screw. (P/N 38846)

   Refer to R37 WRIST MOTOR REPLACEMENT PROCEDURE for accessing the wrist motor set screw.

PROCEDURE 2: DYNAMIC CHECK

The dynamic Robot check determines the OPERATIONAL INTEGRITY and ACCURACY of the Robot. Note that where applicable, there are separate sections for Zymate I and Zymate II Robots.

A. BASEPLATE SECURED

_____Verify that the Robot is securely fastened to its benchtop before performing the dynamic check.

If the Robot has not been properly secured, rotary position errors may be caused by the Robot moving on the benchtop.

CORRECTIVE ACTION **If the Robot is not bolted to the benchtop, attach the Robot using three #10 sheet metal screws (Zymark P/N 36193).**

Note: Unless the Robot is placed in the exact same location, positions may be slightly off. Minor positional corrections will be necessary.

B. POWER ON CHECK

1A. ROBOT INITIALIZATION – ZYMATE I ROBOTS

a. Turn the Robot's power on.

_____b. Verify that the wrist turns CW and then CCW before seeking the ZERO position.

- If a hand is attached, its grip and/or syringe will move to mid-position.

c. Turn the Controller's power ON.

d. Go to the Bench and module setup screen and enter the number for the Robot.

_____e. Verify that the Robot's teaching screen is displayed. (This confirms that initialization occurred). The Robot may also exhibit a slight "jump" at initialization.

- Allow up to one minute for initialization to occur.

CORRECTIVE ACTION

The Robot may fail to initialize IF:

Any system module is unplugged, turned off, or operationally defective. Troubleshoot to find which module is defective by removing modules from the system in some sequence until the defective module is isolated.

The Robot is out of the normal operational range. Move the arm into the normal range and wait for the Robot to initialize.

There is a damaged IC in the wrist electronics board. Early Zymate I Robots had wrist boards with resistors standing on end. These boards are subject to damage if Robot power is OFF while Controller power is ON. Failures of this type should be fixed by replacing the wrist board.

If the Robot does not initialize after the above has been checked, refer to the ZYMATE I INITIALIZATION TROUBLESHOOTING GUIDE to isolate the problem.

1B. ROBOT INITIALIZATION – ZYMATE II ROBOTS

a. Turn the Robot's power ON.

b. Turn the Controller's power ON.

c. Go to the Bench and module setup screen and enter the number for the Robot.

_____d. Verify that the Robot's teaching screen is displayed. This confirms that initialization occurred. The Robot may also exhibit a slight "jump" at initialization.

- Allow up to 15 seconds for initialization to occur.

CORRECTIVE ACTION

The Robot may fail to initialize IF:

Any system module is unplugged, turned off, or operationally defective. Troubleshoot to find which module is defective by removing modules from the system in some sequences until the defective module is isolated.

Robot communication and/or axis problems are identified by a system error prompt. Refer to the ZYMATE II ROBOT INITIALIZATION TROUBLESHOOTING GUIDE to isolate the problem.

C1. CHECK POWER SUPPLY VOLTAGES – ZYMATE I ROBOTS

- There are seven power supply voltages that may be checked with a DVM. Six of these supplies are adjustable.
- The baseboard voltages are measured at capacitors C29, C30 and C31 mounted near the right–rear corner of the baseboard.
- The wrist board voltages are measured at connector P5 found directly above where the coil cord connects.
- Refer to R81 POWER SUPPLY VOLTAGE ADJUSTMENT PROCEDURE for detailed instruction in checking and adjusting these voltages.
- Set the DVM to Volts, DC, 20V scale.

> *Note: Robots built after 8/1/85 have a fixed voltage supply. Refer to the separate, fixed voltage specifications if applicable. If readings do not meet specifications, ignore the Corrective Action section and call Zymark Service.*

1. BASEBOARD POWER SUPPLY VOLTAGES

   a. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)

   b. Measure the voltage at the (+) end of C31.

_____c1. Verify that the voltage reads +13.6 ± 0.1 volt for an adjustable supply.

   c2. Verify that the voltage is between +12.9 and +14.9 volts for a fixed supply.

   CORRECTIVE ACTION **Adjustment may be made by turning the pot marked +12B on the voltage regulator board.**

   d. Measure the voltage at the (–) end of C30.

_____e1. Verify that the voltage reads –13.6 ± 0.1 volt for an adjustable supply.

   e2. Verify that the voltage is between –12.9 and –14.9 volts for a fixed supply.

   CORRECTIVE ACTION **Adjustment may be made by turning the pot marked –12B on the voltage regulator board.**

   f. Measure the voltage at the (+) end of C29.

_____g1.Verify that the voltage reads +5.0 ± 0.1 volt for an adjustable supply.

g2.Verify that the voltage is between +4.7 and +5.3 volts for a fixed supply.

CORRECTIVE ACTION: **Adjustment may be made by turning the pot marked +5B on the voltage regulator board.**

2. WRIST BOARD POWER SUPPLY VOLTAGES

a. Remove any hand that may be attached to the wrist.

b. Unplug the wrist MOTOR connector on the underside of the wrist board before checking or setting the wrist power supply voltages.

c. Connect the negative meter lead to the LEFT end of the 2.2 ohm resistor (red-red-gold-gold) on the wrist board. (When facing front of wrist box).

d. Measure the voltage at P5 PIN 1.

Note: From the top side of the board, PIN 1 is marked with a DOT. The rear row contains (left-to-right) pins, 1, 3, 5 and 7. The front row, pins 2, 4, 6 and 8.

_____e1.Verify that the voltage reads +13.6 ± 0.1 volt for an adjustable supply.

e2.Verify that the voltage is between +12.6 and +14.8 volts for a fixed supply.

CORRECTIVE ACTION **Adjustment may be made by turning the pot marked +12W on the voltage regulator board.**

f. Measure the voltage at P5 PIN 4.

_____g1.Verify that the voltage reads −13.6 ± 0.1 volt for an adjustable supply.

g2. Verify that the voltage is between −13.0 and −15.2 for a fixed supply.

CAUTION: Do not short out pins 4 and 6.

CORRECTIVE ACTION **Adjustment may be made by turning the pot marked −12W on the voltage regulator board.**

h. Measure the voltage at P5 PIN 5.

_____i1. Verify that the voltage reads +8.0 ± 0.1 volt for an adjustable supply.

i2. Verify that the voltage is between +7.4 and +8.8 volts for a fixed supply.

CORRECTIVE ACTION **Adjustment may be made by turning the pot marked +8W on the voltage regulator board.**

j. Measure the voltage at PIN 40 of the 8748 IC.

_____k1. Verify that the voltage reads +5.0 ± 0.2 volts for an adjustable supply.

k2. Verify that the voltage is between +4.7 and +5.3 for a fixed supply.

CORRECTIVE ACTION **This voltage is set by a fixed voltage regulator and cannot be adjusted. Voltage exceeding the specified tolerance indicates either a faulty regulator or abnormal circuit current drain. Call Zymark for assistance.**

l. Plug in the wrist motor connector.

C2. CHECK POWER SUPPLY VOLTAGES – ZYMATE II ROBOTS

1. BASEBOARD POWER SUPPLY VOLTAGES

Check the power supply voltages at TV 1 – 5 on the right-hand edge of the base board.

SUPPLY	*TEST POINT*	*METER READING*
–VS	TV5	–19.4 TO –26.6
+VS	TV4	+19.4 TO +26.6
+5	TV3	+4.7 TO +5.3
–13	TV2	–12.9 TO –14.9
+13	TV1	+12.9 TO +14.9

CORRECTIVE ACTION **If readings do not meet specifications, call Zymark Service for assistance.**

2. WRIST BOARD POWER SUPPLY VOLTAGES

The Controller power should be OFF. Turn the Robot power OFF and then back ON again. This assures that the wrist processor is reset and that the wrist motor is disabled. With the Zymate II Robot it is NOT necessary to unplug the wrist motor to make valid power supply measurements.

REMOVE THE HAND from the wrist if one is attached.

Check the power supply voltages at the TV test point block near the right-hand rear corner of the wrist board. The terminals are not numbered due to space limitations. Start at the front test point and work toward the center of the Robot.

For wrist voltage measurements, connect the meter common lead to the rear terminal in the TV block. This is wrist board ground which is typically 0.3 volts above base board ground.

TERMINAL	*METER READING*
FRONT (+5)	+4.7 TO +5.3
(+8)	+7.4 TO +8.8
(+13.6)	+12.6 TO +14.8
(–13.6)	–13.0 TO –15.2
REAR(GND)	(COMMON)

CORRECTIVE ACTION **If readings do not meet specifications, call Zymark Service for assistance.**

D. LISTEN FOR UNUSUAL SOUNDS

- While operating each axis in the following tests, listen for unusual sounds which may disclose bearing dirt, rubbing or binding, squealing bearings, broken gear teeth, etc.
- Accumulated dirt on the arm and posts can cause erratic crunching sounds. Often this condition can be corrected by thorough cleaning with moderate amounts of oil (electrical motor, automotive engine, etc.). Work the affected axis back and forth while wiping the arm or post. In severe cases it will become necessary to dismantle the arm housing to clean the bearing surfaces.

E. FEEDBACK POT SMOOTHNESS

- During VERTICAL motion, the reach and vertical position feedback pots are continually sending position voltages to the microprocessor. If EITHER pot is intermittently defective, the reach position will fluctuate as the vertical axis moves.
- Do not use the soft function keys to produce the vertical motion. Doing so may result in incorrect readings.
- It is often helpful to lightly mark the arm with a pencil where the arm enters the arm housing. DO NOT USE TAPE. If the arm bearings accidently run over the tape, complete disassembly of the arm housing may be required to clean the tape adhesive from the bearing surfaces.

1. From the Robot teaching screen, use function 7 to produce full vertical motion (0 to 34 cm).

_____2. Verify that there is no excessive IN-OUT fluctuation of the arm as the arm housing rises and descends.

_____3. Verify that the fluctuations do not exceed .04 inch (1 mm).

a. If there is a particular location where the arm "chatters" or "jumps" during vertical travel, change the reach position 5-10 cm and repeat above.

CORRECTIVE ACTION

If the location of the malfunction is DIFFERENT, the REACH pot is defective. Refer to R33 REACH POTENTIOMETER REPLACEMENT PROCEDURE.

If the location is the SAME, the VERTICAL pot is defective. Refer to R55 VERTICAL POTENTIOMETER REPLACEMENT PROCEDURE.

F. MOTOR CURRENT MEASUREMENT

- The mechanical effort required to move each of the three Robot axes can be determined by measuring the motor current required to drive each axis. The current is determined by measuring the voltage drop across three 0.47 ohm sampling resistors located just right of center on the rear of the baseboard. The resistors are color-coded: yellow-violet-silver-gold.
- For Zymate I Robots, the resistors are labelled R36, R37 and R38.
- For Zymate II Robots, the resistors are labelled R12, R13 and R14.
- Measure each axis independently, taking the AVERAGE voltage, not the peak voltage.
- Set the DVM to: Volts, DC, 20V scale.
- Refer to the appropriate sections (Zymate I or Zymate II), for your Robot.
- Set the Robot speed to 0.5 (Zymate II Robot's only).
- Make sure there is no hand attached to the wrist.

1A. ROTARY MOTOR MEASUREMENT - ZYMATE I ROBOTS

a. From the Robot teaching screen, use function 7 to produce full rotary motion (0 to 360 degrees).

> *Note: Do not use the soft function keys to produce the rotary motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R37 while the Robot is moving CLOCKWISE.

_____c. Verify that the average voltage does not exceed .12 volts.

d. Measure the voltage across resistor R37 while the Robot is moving COUNTER CLOCKWISE.

_____e. Verify that the average voltage does not exceed .12 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the rotary axis. Refer to R14 ROTARY MOTOR REPLACEMENT PROCEDURE.**

1B. ROTARY MOTOR MEASUREMENT – ZYMATE II ROBOTS

a. From the Robot teaching screen, use function 7 to produce full rotary motion (0 to 360 degrees).

> *Note: Do not use the soft function keys to produce the rotary motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R12 while the Robot is moving CLOCKWISE.

_____c. Verify that the average voltage does not exceed .12 volts.

d. Measure the voltage across resistor R12 while the Robot is moving COUNTER CLOCKWISE.

_____e. Verify that the average voltage does not exceed .12 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the rotary axis. Refer to R14 ROTARY MOTOR REPLACEMENT PROCEDURE.**

2A. VERTICAL MOTOR MEASUREMENT – ZYMATE I ROBOTS

a. From the Robot teaching screen, use Function 7 to produce full vertical motion (0 to 34cm).

> *Note: Do not use the soft function keys to produce the vertical motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R36 while the Robot is moving UP.

_____c. Verify that the average voltage does not exceed .24 volts.

d. Measure the voltage across resistor R36 while the Robot is moving DOWN.

_____e. Verify that the average voltage does not exceed .06 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the vertical axis. Refer to R20 VERTICAL MOTOR REPLACEMENT PROCEDURE.**

2B. VERTICAL MOTOR MEASUREMENT – ZYMATE II ROBOTS

a. From the Robot teaching screen, use function 7 to produce full vertical motion (0 to 34cm).

> *Note: Do not use the soft function keys to produce the vertical motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R13 while the Robot is moving UP.

_____c. Verify that the average voltage does not exceed .24 volts.

d. Measure the voltage across resistor R13 while the Robot is moving DOWN.

_____e. Verify that the average voltage does not exceed .06 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the vertical axis. Refer to R20 VERTICAL MOTOR REPLACEMENT PROCEDURE.**

3A. REACH MOTOR MEASUREMENT – ZYMATE I ROBOTS

a. From the Robot teaching screen, use function 7 to produce full reach motion (0 to 32cm).

> *Note: Do not use the soft function keys to produce the reach motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R38 while the Robot is moving OUT.

_____c. Verify that the average voltage does not exceed .18 volts.

d. Measure the voltage across resistor R38 while the Robot is moving IN.

_____e. Verify that the average voltage does not exceed .14 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise**

defective motor in the reach axis. Refer to R43 REACH MOTOR REPLACEMENT PROCEDURE.

3B. REACH MOTOR MEASUREMENT – ZYMATE II ROBOTS

a. From the Robot teaching screen, use function 7 to produce full reach motion (0 to 32cm).

> *Note: Do not use the soft function keys to produce the reach motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R14 while the Robot is moving OUT.

_____c. Verify that the average voltage does not exceed .18 volts.

d. Measure the voltage across resistor R14 while the Robot is moving IN.

_____e. Verify that the average voltage does not exceed .14 volts.

CORRECTIVE ACTION **Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the reach axis. Refer to R43 REACH MOTOR REPLACEMENT PROCEDURE.**

PROCEDURE 3: DYNAMIC PERFORMANCE

Checking dynamic performance confirms that the servo-mechanisms controlling Robot positioning are functioning properly.

A. ROTARY

1. SELF RESTORING PLAY

a. Run a program to attach a hand and fully extend the arm.

b. Position the hand near a stationary object so that small, relative rotary position changes can be observed.

c. Using less than 1 lb. of force, manually push the arm first to one side, then the other.

_____d. Verify that the hand returns to the same position within 1mm.

2. ROTARY RESPONSE TEST

a. Alternately strike (TWICE) the CW and CCW function keys.

_____b. Verify that it takes no more than two strikes of the key to produce perceptible rotary movement.

> *Note: If the Robot fails to move, confirm that the rotary values on the teaching screen are changing as the keys are struck. This verifies the integrity of the soft function key switches.*

CORRECTIVE ACTION

1. **Remove the Robot's skirts.**
2. **Check the tightness of the rotary drive drum set screws. Refer to R65 ROTARY DRIVE CABLE REPLACEMENT PROCEDURE for the location of the drum.**
3. **Insure that the Robot is securely mounted to the table.**
4. **Verify that the rotary drive cable tension is correct. A force of approximately 2 lbs. should move the cable .04 to .08 inch (.1 to .2cm). Refer to R6 ROTARY DRIVE CABLE REPLACEMENT for important instructions concerning cable adjustment.**
5. **If performing the corrective action steps above has not corrected the problem(s), adjustment of the rotary gain pot on the Robot baseboard may be necessary.**

Turn the pot CLOCKWISE (increasing gain) in small increments and re-try the rotary procedure(s) after each increment. Turning the pot too far CLOCKWISE may cause the arm to twitch when moving to position rather than decelerate smoothly. After adjusting the rotary gain, use function 7 on the Robot teaching screen to move the rotary axis through a minimum arc of 60 degrees (ex. 150 to 90), and watch for smooth deceleration.

6. **If a problem(s) still exists, call Zymark service for assistance.**

B. VERTICAL

1. UP/DOWN RESPONSE TEST

   a. Alternately strike ONCE the UP/DOWN soft function keys.

_____b. Verify perceptible movement both up and down.

> *Note: If the Robot fails to move, confirm that the vertical values on the teaching screen are changing as the keys are struck. This verifies the integrity of the soft function key switches.*

CORRECTIVE ACTION **Contact Zymark Service for a failure in the vertical response test.**

C. REACH

1. IN/OUT RESPONSE TEST

   a. Alternately strike ONCE the IN/OUT soft function keys.

_____b. Verify perceptible movement.

> *Note: If the Robot fails to move, confirm that the rotary values on the teaching screen are changing as the keys are struck. This verifies the integrity of the soft function key switches.*

CORRECTIVE ACTION **Contact Zymark Service for a failure in the reach response test.**

D. WRIST SELF RESTORING PLAY

1. Run a program to attach a SYRINGE hand (or a GP hand with a pencil in the fingers).
2. Manually rotate the hand (gently) in both directions until slight resistance is felt.
3. Verify that when released from both directions, the hand returns to the same position without overshoot.

CORRECTIVE ACTION — ZYMATE I ROBOTS

For Zymate I Robots (wrist board #37190), failure of the wrist's self restoring play usually indicates a defective motor or component. Call Zymark Service for assistance.

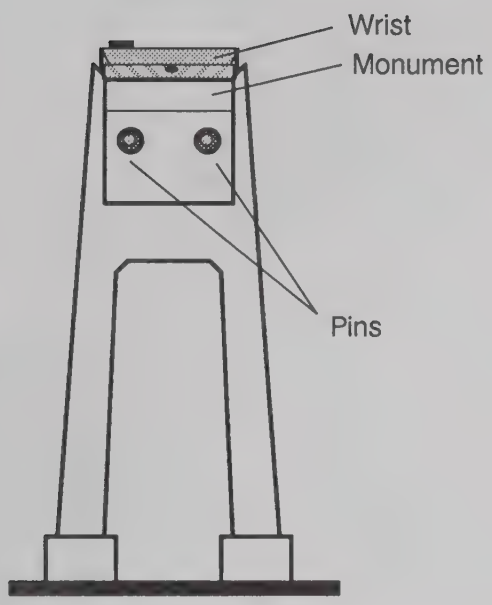
CORRECTIVE ACTION — ZYMATE II ROBOTS

For Zymate II Robots (wrist board #38753) with a wrist self restoring failure:

1. **Remove the wrist cover by loosening the four mounting screws, gently raising the cover and folding it back, so that it rests upside down on the Robot arm.**
2. **Locate the wrist gain pot (R12) on the left rear portion of the wrist board.**
3. **Using a small flat blade screwdriver, turn the pot CLOCKWISE (to increase gain) approximately 10 degrees and re-try steps 2-3 in the WRIST SELF RESTORING PLAY section above.**
4. **If the wrist fails to respond, continue to turn the pot in 10 degree increments and re-try the procedure.**
5. **If the pot has been incremented to its full CLOCKWISE position without any resulting wrist response, call Zymark Service for assistance.**

E. WRIST ZERO

1. Using the Robot teaching screen, move the wrist angle to 0 degrees.
2. Remove any hand from the wrist coupling.



3. Place the monument in a hand parking station.

4. Align the Robot wrist so that the wrist pins are just about to enter the two holes in the monument as shown above.

_____5. Sight through the monument holes and verify that the pins align with the holes.

CORRECTIVE ACTION **The wrist zero can be adjusted by turning the body of its position feedback potentiometer.**

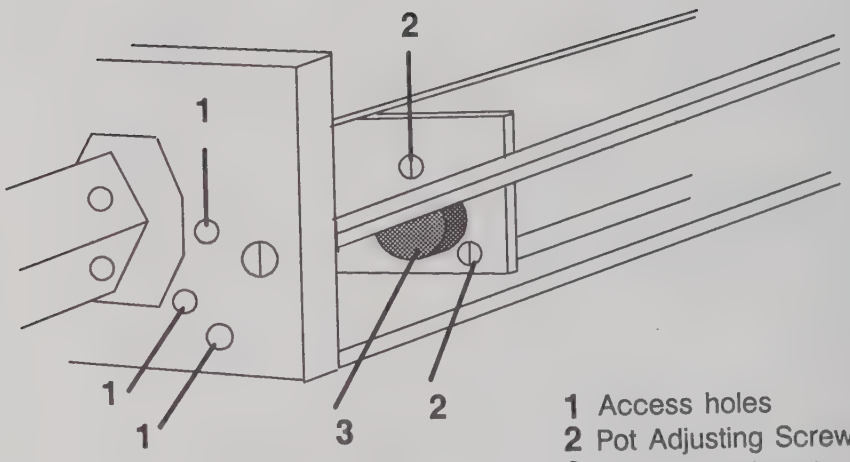
Refer to the figure that follows.

1. Loosen the two pot adjusting screws.

2. Turn the pot body.

3. Retighten the two screws.

Refer to Zymark Service Procedure R34 for additional information if necessary.



1 Access holes
2 Pot Adjusting Screws
3 Wrist Potentiometer

F. POSITION ACCURACY

To measure the true performance capabilities of the Robot, the elimination of any existing calibration factors is necessary. The following steps determine whether the uncalibrated hardware limits of the Robot meet current Zymark standards. It is important to note that adjustment and/or replacement of any potentiometer on the Robot will most likely require re-teaching of positions used within an application. A determination will have to be made as to whether or not a failure to meet certain, uncalibrated performance standards warrants making any adjustments or replacements. It is recommended that customers who have not yet taught positions used in an application make the necessary adjustments to meet Zymark performance standards. Note that this procedure does not apply to Py System Robots.

1. PRELIMINARY

   a. Insert a blank disk into the disk drive and SAVE the current dictionary contents.

> **CAUTION: Failure to perform the SAVE will cause a loss of all calibration factors and dictionary entries.**

   b. Cold start the system to erase all calibration factors.

2. ROTARY POSITION ACCURACY

   a. Remove the Robots skirts.

   b. From the Robot teaching screen, use function 7 to move to the following coordinates: vertical - 0, reach - 32 (or maximum value), rotary - 0.

_____c. Verify that the arm is perpendicular to the rear section of the base.

   d. Use function 7 to move to a rotary position of 360 degrees.

   e. If the arm is not perpendicular to the rear section of the base, use the CW or CCW soft function keys until perpendicularity is reached.

_____f. Reading the rotary value displayed on the Robot teaching screen, verify that the value falls within the rotary displacement specification of 356 to 363 degrees.

CORRECTIVE ACTION **Failure to meet the requirements in steps c or f may necessitate adjustment and/or replacement of the rotary position pot. Refer to R87 ROTARY POTENTIOMETER REPLACEMENT PROCEDURE for details.**

3. REACH POSITION ACCURACY

a. From the Robot's teaching screen, use function 7 to move to the following coordinates: vertical – 34, reach – 32, rotary – 180.

b. Using the 18 inch rule, measure the distance from the front surface of the arm housing to the rear surface of the wrist box. Record the value.

c. Move to the following coordinates: vertical – 0, reach – 32, rotary – 180.

d. Again, measure the distance from the front surface of the arm housing to the rear surface of the wrist box. Record the value.

_____e. Verify that the distance changed less than 0.15 inches. (This checks for excessive vertical/reach interaction).

f. From the current position, use Function 7 to move to reach zero.

g. Remeasure the distance from the front surface of the arm housing to the rear surface of the wrist box. Record the value.

_____h. Subtracting the value recorded in step g from the value recorded in step d, verify that the result falls within the reach displacement specification of 12.40 to 12.80 inches.

CORRECTIVE ACTION **Failure to meet the reach displacement specifications may require adjustment and/or replacement of the reach potentiometer. Refer to R33 REACH POTENTIOMETER SERVICE PROCEDURE for details.**

4. VERTICAL POSITION ACCURACY

a. From the Robot's teaching screen, use function 7 to move to full vertical height of 34cm.

b. Using the 18 inch rule, measure from the top of the turntable cover to the mid–point separation line on the arm housing.

c. Using function 7, move to the zero vertical position.

d. Again, measure from the top of the turntable to the separation line on the arm housing. Record the value.

_____e. Subtracting the value recorded in step d from the value recorded in step b, verify that the result falls within the vertical displacement specification of 13.20 to 13.80 inches.

CORRECTIVE ACTION **Failure to meet the vertical displacement specification may require adjustment and/or replacement of the vertical potentiometer. Refer to R55 VERTICAL POTENTIOMETER SERVICE PROCEDURE for details.**

G. GP HAND ZERO CHECK – ZYMATE I ROBOTS

1. With the GP Hand on the Robot, enter the Hand teaching screen and use function 7 to set the grip to zero.

_____2. Verify that the fingers make contact.

_____3. Using the soft function keys, open the fingers one hit at a time and verify that outward movement is observed before 10 units are reached.

4. Use function 7 to set the grip to 200.

_____5. Using the soft function keys, close the fingers one hit at a time and verify that inward movement is observed before 190 units are reached.

CORRECTIVE ACTION

If the fingers do not make contact at the zero setting, refer to R95 as for setting the GP hand zero.

If there is no movement observed (neither inward nor outward), before 10 soft key hits, continue hitting the keys to verify soft key functionality. If movement is observed at some point after 10 hits, refer to R95 for setting the GP hand zero. If continually hitting the soft function keys fails to generate any movement, call Zymark Service for assistance.

H. GP HAND ZERO CHECK – ZYMATE II ROBOTS

1. With the GP Hand on the Robot, enter the Robot's Hand teaching screen. Display the hand sense information.

_____2. Close the grip to zero and verify that the fingers are making contact and the grip force value is less than 0.1.

_____3. Open the grip to 200 and verify that the grip force value is less then 0.1.

CORRECTIVE ACTION

If the fingers fail to make contact, and/or any grip force value is greater than 0.1, refer to R95 for setting the GP hand zero.

I. GP HAND GAIN CHECK – ZYMATE II ROBOTS

Note: Zymate I Robots have no GP hand gain adjustment.

1. With the GP Hand on the Robot, enter the Hand teaching screen.

_____2. Alternately strike the "OPEN" and "CLOSE" function keys several times and confirm that the fingers physically move each time a key is struck.

CORRECTIVE ACTION

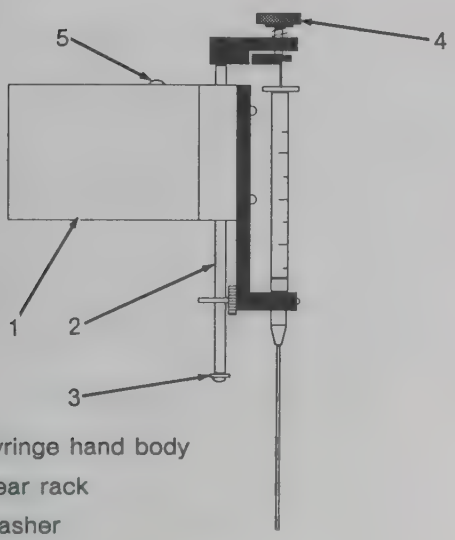
If the fingers do not move each time, or the fingers sometime oscillate, the hand gain should be adjusted:

1. **Loosen the four screws securing the wrist cover, carefully lift the cover, and "hinge" it back so that it rests on the Robot arm.**
2. **Locate the GP gain adjust pot (R5) in the center of the wrist board.**
3. **Enter the Robot hand screen and use the "OPEN" function key to open the fingers 30 units.**
4. **Using a small screwdriver, turn the gain pot CW until the fingers oscillate. Then slowly turn the pot CCW until the oscillation just stops. Continue turning the adjustment CCW an additional 1/8 turn.**
5. **Recheck the gain as above.**
6. **Reinstall the wrist cover.**

J. SYRINGE HAND ZERO CHECK

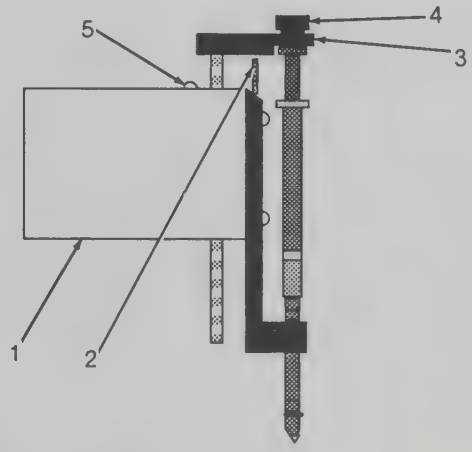
This section deals with two styles of Syringe Hands commonly shipped with Zymate Systems. Figure A shows the hand style typical for most non-Py systems. Figure B shows the hand style typical for most Py-configured systems. Examine the two figures below to determine which style hand(s) your Zymate System has. Note that the push rod [2] in Figure B is the major distinguishing feature between the two hands. Refer to the appropriate zero check section for your particular hand style. Earlier Syringe Hands with potentiometers and motors mounted on the sides of the hand body are not covered in this procedure. Refer to R57 for hand zero and gain checks on this style hand.

Figure A



1. Syringe hand body
2. Gear rack
3. Washer
4. Knob
5. Plastic plug

Figure B



1. Syringe hand body
2. Pushrod
3. Plunger mounting block
4. Knob
5. Plastic plug

1. SYRINGE HAND ZERO CHECK I - Figure A style hand

a. With the Syringe Hand on the Robot, enter the Robot teaching screen and open the syringe axis to the 200 unit setting.

_____ b. Verify that there is a 1/16 to 1/8 inch gap between the bottom of the syringe hand body [1] and the inside of the washer [3] on the bottom-end of the gear rack [2].

CORRECTIVE ACTION **If the gap checked above does not meet the specified range, refer to R96 for setting the Syringe Hand zero.**

2. SYRINGE HAND ZERO CHECK II – Figure B style hand

a. With the Syringe hand on the Robot, enter the Robot teaching screen and move the syringe axis until the pushrod [2] is just contacted by the syringe plunger mounting block [3].

_____b. Read the syringe axis value from the teaching screen. Verify that the value falls within the 27 to 33 unit range.

CORRECTIVE ACTION **If the syringe value falls outside the specified range, refer to R96 for setting the Syringe Hand zero.**

K. SYRINGE HAND GAIN CHECK

This section is applicable to both Syringe Hand styles described in section I. Use either Figure A or Figure B when referring to location details.

1. With the Syringe Hand on the Robot, enter the Hand teaching screen.

_____2. Alternately strike the "FILL" and "DISPENSE" function keys several times and confirm that the syringe physically moves each time.

CORRECTIVE ACTION **If the syringe does not move each time, or if the syringe sometimes oscillates, the gain should be adjusted. Refer to the previous figures for details. To adjust the gain:**

1. **Loosen and remove the knob [4] that attaches the syringe plunger to the gear rack mechanism.**
2. **Enter the Hand screen and use the "FILL" function key to raise the gear rack mechanism 10 units.**
3. **Remove the small plastic plug [5] from the top of the Syringe Hand to allow access to the gain pot adjustment screw.**
4. **Using a small screwdriver, turn the gain pot adjustment CW until the syringe oscillates. Then slowly turn the adjustment CCW until the oscillation just stops. Continue turning the adjustment CCW an additional 1/8 turn.**
5. **Reinstall the knob [4].**
6. **Recheck the gain.**
7. **Reinstall the plastic plug [5].**

L. PARKING STATION ALIGNMENT

The parking station is adjusted at the factory to provide smooth hand attachment and parking. If smooth attachment and parking is not being achieved and it is due to robotic positioning, the Parking Station may require further adjustment.

Manually slide the hand in and out of its parking station. The station should provide a firm but smooth capture of the hand. If this is not observed, perform the following procedure for station adjustment.

This procedure:

- Adjusts the detents so they provide a positive capture of the hand in the station.
- Adjusts the guide pins so they guide and locate the hand properly in its station.

1. Place the hand in its parking station.
2. Using a flat blade screwdriver, turn both detents counter-clockwise until they do NOT contact the hand.
3. Using a 3/32 Allen wrench, adjust the four guide pins to:
   - Firmly guide the hand.
   - Center the hand in the station.
   - Make sure the bottom of the hand sits FLAT on the parking station.
   - Provide some tightness when sliding the hand into and out of the parking station.
4. Loosen the two guide pins on one side 1/8 turn.
5. Adjust the detents.
   a. Turn one detent CW until it produces a GENTLE snap action when the hand moves in and out of the station.
   b. Turn this detent EXACTLY 1/2 turn CCW to disable the action.
   c. Adjust the other detent to obtain a gentle snap action.
   d. Turn the first detent 1/2 turn CW so that both detents are now contributing to an overall gentle, but positive, capture of the hand.

   BLANK HANDS GENERALLY REQUIRE MORE DETENT ACTION TO HOLD HAND IN THE STATION.

M. HAND/WRIST MATING

1. Ensure that the parking station is square with the wrist coupling:

   a. Place the hand in the parking station.

   b. From the Robot teaching screen, use the function keys to extend the arm out until the hand is attached.

   c. Sight down on the mating surface of the wrist and hand.

   _____d. Verify that there is no angled gap between these two surfaces.

   CORRECTIVE ACTION **Adjust by rotating the parking station (loosen the black knob and twist the station) until the wrist coupling contacts the parked hand along the entire edge of the mating surface.**

2. Run a HAND PARKING exercise program to verify proper hand/wrist mating. Refer to "Maintaining the Zymate I or Zymate II System", HAND PARKING OPERATION CHECK SECTION.

ROTARY POSITION TEST PROCEDURE

PROCEDURE SCOPE:

The Rotary Position Test procedure describes a series of checks that determine the rotary positioning accuracy and precision of the Robot. Use this procedure to isolate problems that directly or indirectly cause rotary positioning errors.

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor correction is provided where appropriate. Procedures for the replacement of parts are provided as well as in-depth troubleshooting information in this chapter of the Zymark Service Manual.

TOOLS REQUIRED:

Screwdriver, flatblade, 3/16, 1/8
Screwdriver, holding
Driver, ball-end hex, 9/64
Wrench, open box-end, 5/16
Wrench, hex (Allen), 9/64, 3/32, .050
Digital Voltmeter (DVM)
Fine Point felt tip pen
Adhesive-backed label
Ruler
Cotton swabs
Spring scale

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: INITIAL CHECKOUT

Perform the following checks to determine whether your Robot's rotary positioning errors are caused by problem areas indirectly related to the rotary axis. The few minutes required for these initial checks can sometime avoid hours invested in unproductive troubleshooting.

A. BASEPLATE SECURED

_____Verify that the Zymate Robot is securely fastened to its benchtop.

If the Zymate Robot has not been properly secured, rotary position errors may be caused by the Zymate Robot MOVING on the benchtop.

CORRECTIVE ACTION **If the Zymate Robot is not bolted, attach the Robot to the table using three #10 sheet metal screws.**

NOTE: Unless the Zymate Robot is placed in the exact same location, positions may be slightly off. Minor positional corrections will be necessary.

B. ROTARY POTENTIOMETER EQUIPPED WITH METAL COUPLING (Zymate I Robots)

Replacing the rubber couplings with the metal design improves rotary positioning accuracy.

1. Remove the Robot's skirts.
2. Inspect the shaft coupling on the rotary potentiometer.

_____3. Verify that it is an all-metal shaft coupling.

CORRECTIVE ACTION

Early Zymate I Robots were built using rubber couplings having metal hubs on each end. These couplings should be replaced. Refer to R87 ROTARY POTENTIOMETER REPLACEMENT or R28 ROTARY SERVO CABLE REPLACEMENT for information.

C. REACH BEARINGS PROPERLY ADJUSTED

1. With the Controller and Robot power OFF, manually extend the arm through its full reach.

_____2. Feel for any binding while moving the arm.

_____3. Standing in front of the wrist box, check for any bearing sloppiness by rocking the wrist side to side.

CORRECTIVE ACTION

Use the Allen wrench to loosen (approximately 2 turns) the four set screws that secure the reach bearings.* Two are located on the arm housing just above and below the point where the arm exits the front of the housing. The other two are located exactly 180° opposite, at the point where the arm exits the rear of the housing.

** Robots built prior to 6/88 may not contain the securing set screws.*

Adjust the bearings by locating the two small holes in the top of the arm housing for bearing adjustment. Using a small screwdriver, turn the front bearing adjustment COUNTER-CLOCKWISE until tight. Turn the screw CLOCKWISE 1/16 to 1/8 turn. Repeat these steps for the rear adjustment.

Retighten the four securing set screws until snug.

Refer to R11 REACH BEARING ADJUSTMENT for more detailed information.

D. WRIST BOLTS TIGHT

_____Using a 5/16 inch wrench, check the tightness of the four bolts securing the wrist to the arm.

CORRECTIVE ACTION

If the two bolts on the arm surface were loose, check that epoxy has been applied as a gap filler between the inside of the arm tube and the wrist adaptor. If epoxy is not present, contact Zymark Service or refer to R40 REACH BEARING AND ARM REPLACEMENT PROCEDURE.

If the two bolts securing the wrist adaptor to the wrist were loose, tighten them securely.

E. VERIFY WRIST SELF-RESTORING PLAY

1. Turn the Robot and Controller power ON.
2. Run a program to attach a GP hand.
3. Have it grasp an indicator (e.g. small screwdriver, pencil, etc.) vertically.
4. Move the arm until the indicator held in the hand appears near a stationary reference mark.
5. GENTLY turn the wrist in both directions and release it.

_____6. Verify that the indicator (measured approximately 6 inches from the center of rotation of the wrist) returns within 0.06 inches to its reference.

CORRECTIVE ACTION

ZYMATE I ROBOTS

For Zymate I Robots (wrist board #37190), failure of the wrist's self-restoring play usually indicates a defective motor or component:

1. Nylon servo pot wrist gears found in early Zymate I Robots need an anti-backlash gear update: Refer to R71 ANTI-BACKLASH GEAR INSTALLATION.
2. Loose wrist motor set screw: Refer to R37 WRIST MOTOR SERVICE for location of the wrist motor set screw.
3. Defective wrist motor: Refer to R37 WRIST MOTOR SERVICE for replacement of the motor.

CORRECTIVE ACTION

ZYMATE II ROBOTS

For Zymate II Robots (wrist board #38753) with a wrist self-restoring failure:

1. Remove the wrist cover by loosening the four mounting screws, gently raising the cover and folding it back so that it rests upside down on the Robot arm.
2. Locate the wrist gain pot (R12) on the left rear portion of the wrist board.
3. Using a small flat blade screwdriver, turn the pot CLOCKWISE (to increase gain) approximately 10 degrees and re-try steps 2-3 in the WRIST SELF-RESTORING PLAY section above.
4. If the wrist fails to respond, continue to turn the pot in 10 degree increments and re-try the procedure.
5. If the pot has been incremented to its full CLOCKWISE position without any resulting wrist response, call Zymark Service for assistance.

PROCEDURE 2: ROTARY TEST PROCEDURE

A. PREPARE THE ROBOT FOR THE TEST

1. Turn the Robot and Controller power ON.
2. Run a program to attach a GP hand to the wrist.
3. Use the Robot teaching screen function keys to grasp a fine-point felt tip marker or pencil vertically in the hand.
4. Move the arm to full reach.
5. Attach a blank adhesive-backed label to a flat smooth object which can be raised to a height above the benchtop that the marker can reach.
6. Set the speed to 0.5 (for Zymate II Robot's only).

B. CREATE THE ROTARY TEST PROGRAM

1. Using the Robot's teaching screen, teach the Robot the following locations with the arm at full reach:
   a. MARK (ABSOLUTE location) - Marker touches label
   b. CENTER (ABSOLUTE location) - Location 1.0 cm ABOVE "MARK"
   c. LEFT (RELATIVE location) - Rotary move 60 degrees CLOCKWISE from "CENTER"
   d. RIGHT (RELATIVE location) - Rotary move 60 degrees COUNTER-CLOCKWISE from "CENTER"
2. Go to the EDIT PROGRAM section of the Controller.
3. Write the ROTARY TEST program as follows:

   EasyLab Program Name: ROT.TEST

```
DO 10 TIMES
CENTER
TIMER(1)=4
WAIT FOR TIMER 1
MARK
CENTER
LEFT
CENTER
TIMER(1)=4
WAIT FOR TIMER 1
MARK
CENTER
RIGHT
ENDDO
```

C. RUN THE ROTARY TEST PROGRAM

DVM Set to: Volts, DC, 20V scale

1. Attach the POS lead of the DVM to ROTARY MOTOR TERMINAL #1.
2. Attach the NEG lead of the DVM to ROTARY MOTOR TERMINAL #2.
3. Run the ROT.TEST program in the Direct Control mode.
4. Reposition the label slightly after the program starts so the marker touches a clean area on the label.
5. Fill out the ROTARY TEST WORKSHEET provided at the back of this document and perform the calculations as directed.

D. RESULTS OF ROTARY TEST PROGRAM (Obtain values from Worksheet)

1. Motor voltage readings:
   a. CCW direction:
   b. CW direction:
2. True Overlap:
   a. TRUE OVERLAP value:
3. Cluster size:
   a. Length of CW clusters:
   b. Length of CCW clusters:

E. ROTARY SPECIFICATIONS

Compare the results obtained from the ROTARY TEST with the ROTARY SPECIFICATIONS listed below:

1. Motor voltage less than or equal to 1.2 V from each direction.
2. Total overlap or underlap calculated between 0.00 and 0.08 inches.
3. Marks made from EACH direction must cluster within 0.02 inches.

RESULTS EXCEEDING ANY OF THESE SPECIFICATIONS INDICATE THAT TROUBLESHOOTING SHOULD BE PERFORMED!

F. ROTARY SPECIFICATION FAILURES

FAILURE: EXCESSIVE MOTOR VOLTAGE

Excessive motor voltage indicates binding in the drive mechanism or a defective motor that is unable to drive the rotary mechanism fully into position.

Refer to PROCEDURE 3: ROTARY DRIVE TROUBLESHOOTING.

FAILURE: EXCEESIVE UNDERLAP

Underlap indicates that the rotary axis is binding and/or the motor can't quite drive the arm to final position. This condition is usually associated with excessive motor voltage.

Refer to PROCEDURE 3: ROTARY DRIVE TROUBLESHOOTING.

FAILURE: EXCESSIVE OVERLAP

EXCESSIVE overlap may indicate binding or looseness in the position feedback system. This can cause the signal from the feedback pot to "run behind" as the rotary approaches the desired position.

Refer to PROCEDURE 4: ROTARY FEEDBACK TROUBLESHOOTING.

FAILURE: EXCESSIVE CLUSTER SIZE

Poor reproducibility of position from one approach direction is an indication that the problem resides in either the drive or feedback section. If the problem did not show up in the overlap measurement, BOTH mechanisms may be at fault.

Refer to the ROTARY DRIVE TROUBLESHOOTING procedure FIRST. If the drive checks out, try the FEEDBACK TROUBLESHOOTING section.

G. ROTARY TEST NOTES

Results WITHIN the rotary specifications usually indicate that the Robot's rotary mechanisms are functioning properly. However, certain conditions can cause sub-standard rotary performance that may not always show up during the rotary test. These conditions and their symptoms are discussed below.

1. HUMIDITY AND CONTAMINATION on the Robot's baseboard can cause inconsistent rotary positioning.

   Consult Zymark Service if you suspect a problem exists with humidity or contamination.

2. TEMPERATURE CHANGES can produce small rotary position errors. These errors become more noticeable at maximum reach and rotation angles.

   Effects of temperature can be reduced by placing the most critical bench positions at small rotary angle values.

3. As the temperature changes within the Robot during WARM-UP, rotary positioning differences can occur. Again, these differences become more noticeable at maximum reach and rotation angles.

   Effects of warm-up error can be eliminated by exercising the Robot as follows: (1) if the Robot was off overnight, run a program to exercise all Robot axes for 10 minutes, (2) if the Robot was off for any time period longer than overnight, (for example, over the weekend), run a program to exercise all Robot axes for 30 minutes.

4. Failure of the Robot's ROTARY SELF-RESTORING PLAY can result in erratic positioning in the rotary axis. Perform the following steps if your Robot is exhibiting rotary positioning inconsistencies:

   1. Extend the Robot's arm to full reach over a convenient area of the benchtop.

   2. Using less than one pound of force, gently push the wrist sideways in one direction until a slight resistance is felt. Mark this position in some manner. *Hint: position an object such as a carpenter's square against one of the wrist pins.*

   3. Release the wrist and gently push it sideways in the opposite direction until a slight resistance is felt. Again, mark the position in a similar manner.

   4. Release the wrist and measure the distance between the two marked positions.

   5. The distance should not exceed 3/8 inch.

      Results exceeding this indicate the following possibilities:

      a. Loose rotary drive drum set screw. – Tighten the set screw at the motor end of the drive drum.

      b. Loose rotary drive cables. – Tighten the rotary drive cable according to the procedure in R65 ROTARY DRIVE CABLE REPLACEMENT.

      c. Defective motor gears – Replace the rotary drive motor according to R14 ROTARY MOTOR SERVICE.

> *Note: If the wrist does not return back to the original position after being pushed sideways, then a binding problem exists somewhere in the rotary drive mechanism. Refer to PROCEDURE 3: ROTARY DRIVE TROUBLESHOOTING.*

5. ERRATIC MOVEMENT only in the CCW direction indicates an intermittently defective rotary pot. – Replace the pot according to the procedure in R87 ROTARY POTENTIOMETER REPLACEMENT.

PROCEDURE 3: ROTARY DRIVE TROUBLESHOOTING

A. INITIAL CHECKS

1. Robot skirts clear the turntable:

   a. Verify that the skirts clear the turntable by manually moving the Robot in the rotary axis and listening for any rubbing sounds.

   b. Remove the skirts and visually check for signs of rubbing.

2. Verify correct rotary servo gain for Zymate II Robots and Zymate I Robots with single gain pots on the baseboard:

   a. Turn the Robot and Controller power ON and set the arm to maximum reach.

   b. Turn the pot until the arm begins to oscillate.

   c. Turn the pot BACK until the oscillation JUST stops.

   d. Turn the pot BACK an additional 1/8 turn.

3. Verify correct rotary servo gain for Zymate I Robots with three gain pots on the baseboard. (The rotary pot is leftmost pot). Follow the same sequence of steps in 2a - 2d above.

4. For early Zymate I Robots only, verify that the black, rotary electrical cable under the turntable forms a smooth helix, with each turn lying on top of the one below.

5. Verify that the rotary motor drive drum is not rubbing on the inside of the pulley mount assembly.

6. Verify that each of the four rotary drive pulleys on the pulley mount assembly is spaced away from the assembly with a washer.

B. ROTARY CURRENT TEST

- The mechanical effort required to move the Robot in the rotary axis can be determined by measuring the motor current. The current is determined by measuring the voltage drop across an 0.47 ohm sampling resistor located just right of center on the rear of the baseboard. The resistor is color-coded: yellow-violet-silver-gold.
- For Zymate I Robots, the resistor is labelled R37.
- For Zymate II Robots, the resistor is labelled R12.
- Take the AVERAGE voltage, not the peak voltage.
- Set the DVM to: Volts, DC, 20V scale.

- Refer to the appropriate sections (1A OR 1B) for your Robot.

1A. ROTARY MOTOR MEASUREMENT – ZYMATE I ROBOTS

a. From the Robot teaching screen, use function 7 to produce full rotary motion (0 to 360 degrees).

> *Note: Do not use the soft function keys to produce the rotary motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R37 while the Robot is moving CLOCKWISE.

_____c. Verify that the average voltage does not exceed .12 volts.

d. Measure the voltage across resistor R37 while the Robot is moving COUNTER-CLOCKWISE.

_____e. Verify that the average voltage does exceed .12 volts.

CORRECTIVE ACTION

Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the rotary axis. Refer to R14 ROTARY MOTOR REPLACEMENT PROCEDURE.

Early Zymate I Robots using a black helical ROTARY ELECTRICAL CABLE may exhibit high rotary current for CW rotation as the axis nears 360 degrees. This should be corrected by aligning the cable so that it coils uniformly. The cable should also be lubricated with a coating of silicone grease.

1B. ROTARY MOTOR MEASUREMENT – ZYMATE II ROBOTS

a. From the Robot teaching screen, use function 7 to produce full rotary motion (0 to 360 degrees).

> *Note: Do not use the soft function keys to produce the rotary motion. It may result in incorrect readings.*

b. Measure the voltage across resistor R12 while the Robot is moving CLOCKWISE.

_____c. Verify that the average voltage does not exceed .12 volts.

d. Measure the voltage across resistor R12 while the Robot is moving COUNTER-CLOCKWISE.

_____e. Verify that the average voltage does not exceed .12 volts.

CORRECTIVE ACTION

Excessive voltage (current) indicates a binding or high friction component, damaged motor gearbox, or otherwise defective motor in the rotary axis. Refer to R14 ROTARY MOTOR REPLACEMENT PROCEDURE.

PROCEDURE 4: ROTARY FEEDBACK TROUBLESHOOTING

A. ROTARY SERVO CABLE TENSION

The ROTARY SERVO cable is the thinner of the 2 cables wound around the turntable.

1. Remove the Robot skirts.
2. Grasp either section of the cable between the turntable and the rotary servo pot assembly and pull the cable sideways.

_____3. A force of approximately 2 lbs. should move the cable .15 to .20 inch (.4 to .5 cm).

CORRECTIVE ACTION — **Adjustment of the rotary servo cable tension involves moving the rotary pot assembly away from, or toward the turntable.**

1. **Loosen the two allen head screws that secure the rotary pot assembly to the baseplate.**
   - **Leave each of these screws just tight enough to permit the assembly to slide on the baseplate, but still tight enough so that the assembly doesn't tip toward the turntable.**
2. **Turn the long adjustment screw that runs through the base of the assembly to adjust the cable tension.**
3. **After adjustment is made, retighten the two assembly mounting screws.**
4. **Tightening of the asembly screws may further increase cable tension. Check cable tension after the assembly screws are tightened, and readjust as necessary.**

   Refer to R28 ROTARY SERVO CABLE REPLACEMENT PROCEDURE for more detailed information.

B. POTENTIOMETER FLEX COUPLING

_____1. Verify that the Robot is equipped with a single-piece metal flex coupling.

CORRECTIVE ACTION — **The rubber coupling found in some early Robots are less stiff and should be replaced for optimum rotary performance. Refer to R87 ROTARY POTENTIOMETER REPLACEMENT for more information.**

_____2. Verify that the flex coupling is mounted high on the pot coupling shaft.

CORRECTIVE ACTION

It is permissable for the coupling hub to touch the bearing above it. If too low, the coupling's UPPER set screw may not properly engage a slot provided in the shaft. Refer to R87 ROTARY POTENTIOMETER REPLACEMENT for an indication of the coupling's location.

C. FASTENERS TIGHT

_____1. Verify that both flex coupling set screws are tight.

_____2. Verify that the rotary servo drum set screw is tight.

Note: If the rotary servo drum set screw was loose, remove it and reapply Loctite 222®. Reinsert the screw and tighten securely against the flat on the shaft.

_____3. Using the 9/64 ball-end wrench, verify that the two allen heads that secure the rotary pot assembly are tight.

_____4. Verify that the two screws securing the cleats to the rotary pot assembly are just SNUG.

CORRECTIVE ACTION

Pertains to Zymate I Robots with a separate top plate on the rotary pot assembly.

1. **Drum too low on shaft:**
   a. **Loosen the set screw in the rotary servo drum.**
   b. **Push down on top of shaft at top plate.**
   c. **Retighten drum set screw.**
2. **If there is still no perceptible vertical movement, replace the whole pot assembly. Refer to R28 ROTARY SERVO CABLE REPLACEMENT for information.**

D. MISCELLANEOUS CHECKS

1. Verify that the rotary servo cable is not crossed at any point and reels smoothly on and off the turntable and drum.

_____2. If applicable (for early Zymate I Robots), verify that the top plate is aligned over the drum in the rotary pot assembly.

CORRECTIVE ACTION **Some rotary pot assemblies are made with a separate plate mounted on the top of the assembly. It contains a small bearing and is attached with a single Phillips head screw.**

_____3. Verify that the flex coupling is not compressed. This condition is caused by tightening the two pot adjustment screws during pot installation.

CORRECTIVE ACTION **This condition can be easily corrected by loosening and retightening the LOWER set screw.**

E. POT OTHERWISE DEFECTIVE

If the rotary test failure is due to an EXCESSIVE OVERLAP condition and the troubleshooting procedure did not uncover any other defects, replace the rotary potentiometer. Refer to R87 ROTARY POTENTIOMETER PROCEDURE.

ROTARY TEST WORKSHEET

Rotary position accuracy can be determined by measuring the distance between the marks made from the CW and CCW directions. Also, any variance from the true position is indicated by the voltage left on the motor as the label is being marked. By following the procedure below, the TRUE OVERLAP can be calculated by adding the CALCULATED OVERLAP to the MEASURED OVERLAP.

1. RUN THE ROT.TEST program.
2. Record the motor voltage as the label is being marked from EACH direction. (Record an average value taken from several markings).
3. Voltage and Polarity from the CCW direction:_____
4. Voltage and Polarity from the CW direction:_____
5. Change the sign of the CW direction:_____
6. Add the voltages from the CW and CCW directions:_____

7a. For Zymate I Robots, multiply the value in step 6 by .025_____ (calculated overlap)

7b. For Zymate II Robots, multiply the value in step 6 by .012_____ (calculated overlap)

8. Enter the MEASURED OVERLAP from the rotary test label_____ (measured overlap).
9. Add step 7 and 8 _____ (true overlap)

Note: Underlap is calculated as negative overlap.

PY ROBOT CALIBRATION PROCEDURE

PROCEDURE SCOPE:

This procedure covers the steps necessary to recalibrate a Py Robot. Follow this procedure ONLY if your Py Robot has recently undergone service that affects Py calibration factors (for example, any pot replacement or adjustment, cable replacement, etc.).

TOOLS REQUIRED:

12 inch steel rule
Flatblade screwdriver

PROCEDURE 1: ZERO CHECKS AND ADJUSTMENTS

This procedure checks and (if necessary), adjusts the zero position accuracy of all three base axes. DO NOT make any adjustments unless an axis fails its zero check.

A. PRELIMINARY

Before any attempt to check the Robot's calibration, it is important to verify that the Robot is operating to acceptable standards. Check that the Robot:

1. Has its REACH BEARINGS properly adjusted (refer to MAINTAINING THE ZYMATE II SYSTEM).
2. Can move each base axis with ONE stroke of the soft key (refer to PROCEDURE 3 of the ZYMATE I/II ROBOT AND HAND PERFORMANCE CHECK.
3. Passes the ROTARY POSITION TEST PROCEDURE.
4. Has its wrist properly zeroed (refer to MAINTAINING THE ZYMATE II SYSTEM).

If you have verified that the Robot meets the above criteria, proceed to section B. If the Robot fails to meet the above criteria, perform the necessary adjustments before proceeding to section B.

B. LOAD CORE DISK AND SETUP GP PYSECTION

1. LOAD the core diskette and power cycle the Controller.
2. Remove a GP Hand PySection from one of the core sectors and place it in sector 48. Do NOT PYAPPEND the section in place.
3. Center the mounting holes within the slots in the Pycore plate and secure the section in place using two tee nuts.
4. Place the monument in the station.

C. ROTARY ZERO CHECK

1. From the Robot teaching screen, use the soft function keys to position the Robot to:

   a. VERTICAL.....0.6 cm
   b. REACH.....29.5 cm
   c. ROTARY.....0.0 degrees

2. Check that the wrist pins are centered (in the ROTARY axis only) within the holes of the monument. If OK, proceed to the VERTICAL ZERO CHECK section.

3. If NOT, adjust the rotary pot (if necessary, refer to R87, ROTARY POT SERVICE PROCEDURE for assistance) until centering is achieved.

D. VERTICAL ZERO CHECK

1. Using the soft function keys, move the reach to 30.5 cm.
2. Check that the wrist pins are centered (in the VERTICAL axis) within the holes of the monument. If OK, proceed to the REACH ZERO CHECK section.
3. If NOT, adjust the vertical pot (if necessary, refer to R55, VERTICAL POT SERVICE PROCEDURE for assistance) until centering is achieved.

E. REACH ZERO CHECK

1. Using the soft function keys, move the reach to 3.0 cm.
2. Hold the edge of the steel rule against the face of the wrist coupling so that the rule extends down to the edge of the core mounting disk. Make sure that the rule remains flush with BOTH the upper and lower wrist coupling faces.
3. Check that the inside edge of the rule JUST makes contact with the outside edge of the core mounting disk. If OK, go to PROCEDURE 2.
4. If NOT, adjust the reach pot (if necessary, refer to R33, REACH POT SERVICE PROCEDURE for asssistance) until correct positioning is achieved.

PROCEDURE 2: CALIBRATION

This procedure describes the steps to check and adjust (if necessary) the Py Robot. Do NOT perform any calibration unless one or more of the three Robot axes fails its check.

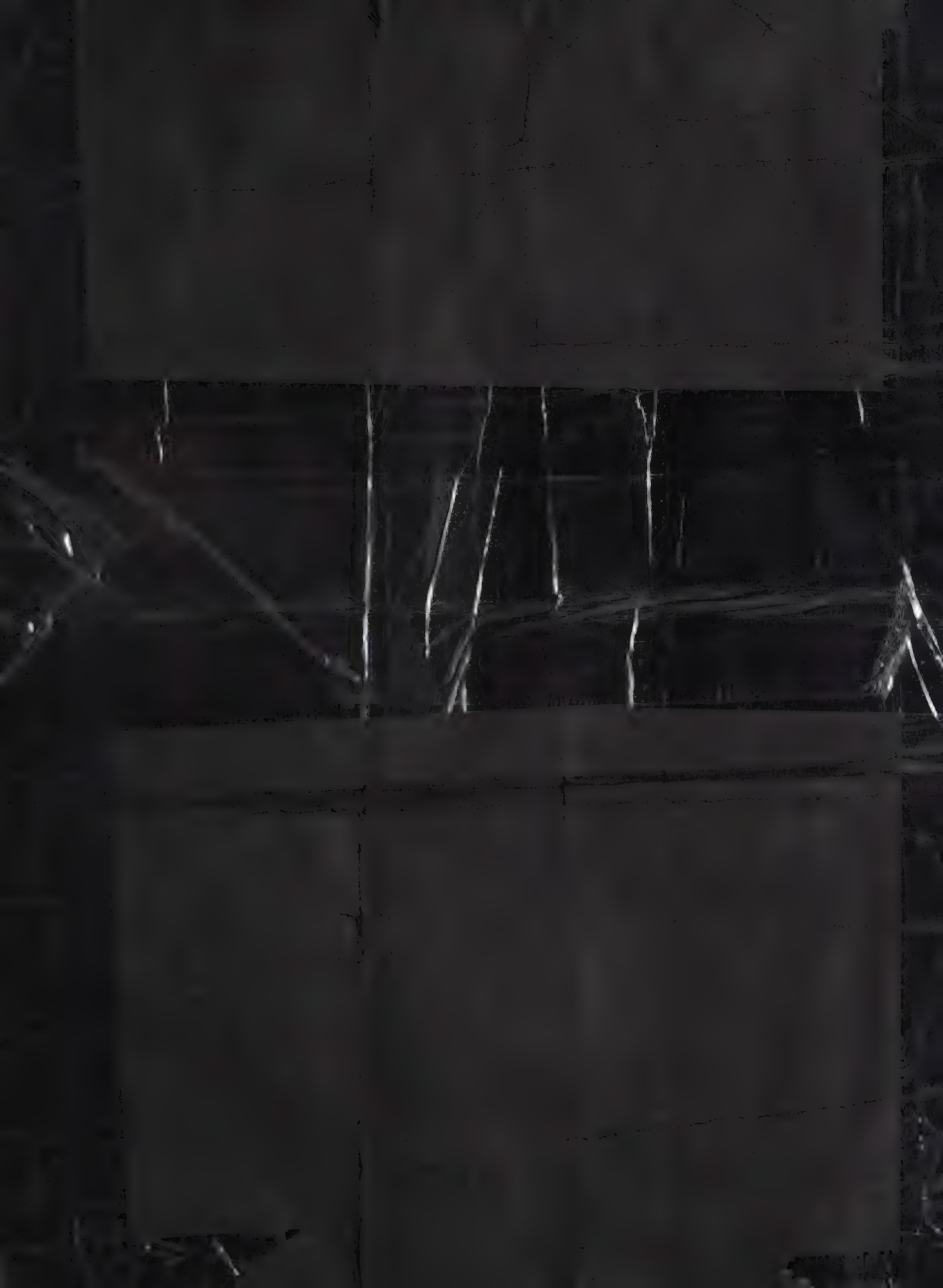
A. ROTARY AND REACH AXES

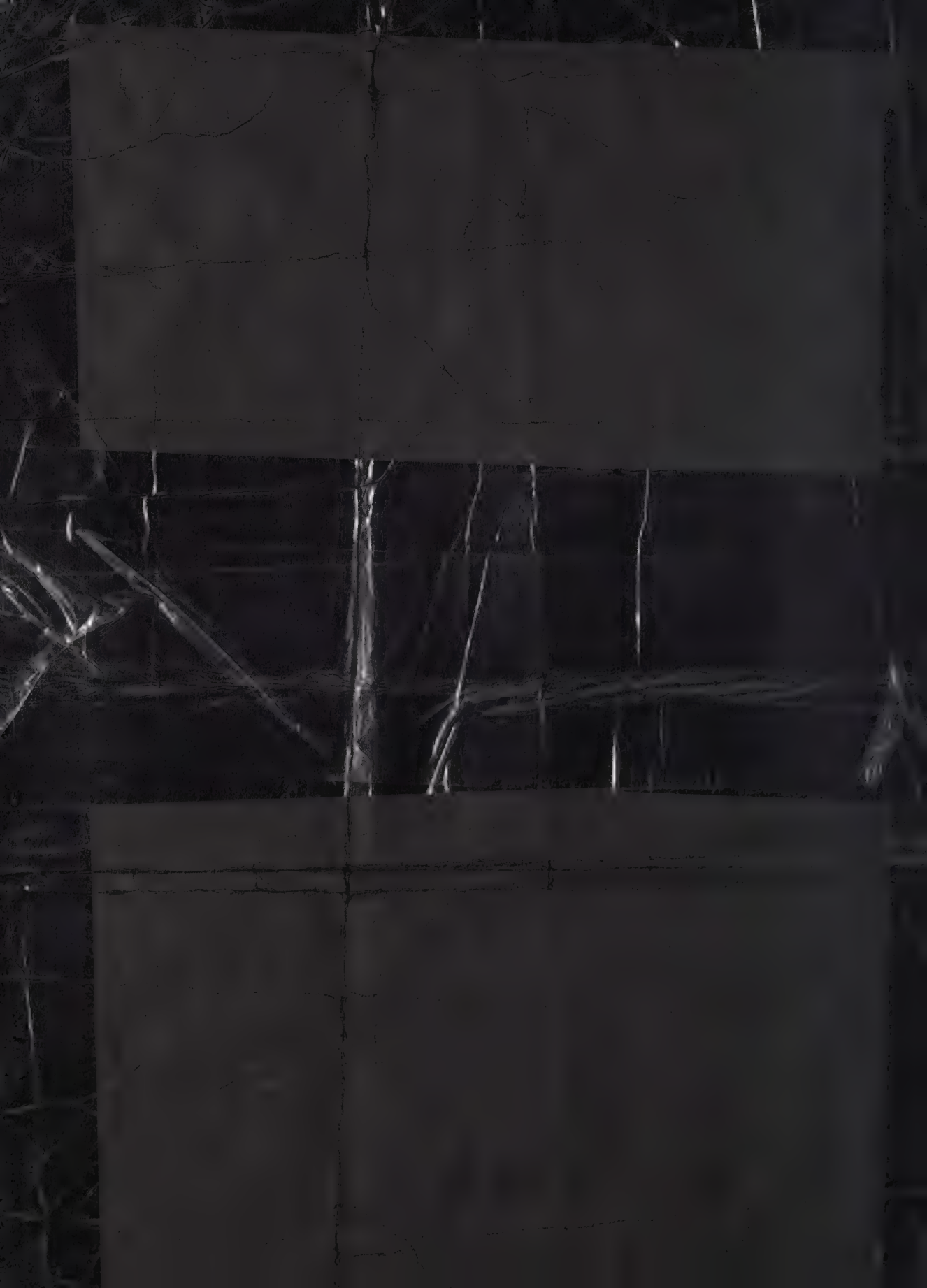
1. From the Robot teaching screen, use the soft function keys to move the arm to the 360 degree position.
2. Again, use the soft function keys to extend the arm to a reach position of 31.1 cm. The combination of these two moves should engage the wrist pins in the monument.
3. Verify if the following is true:
   a. the wrist pins are centered within the monument holes.
   b. the wrist coupling face JUST touches the inside edge of the monument.
4. If the above criteria are met, proceed to section B.
5. If either or both criteria are NOT met, use the appropriate soft function key(s) until positioning is correct.

B. VERTICAL AXIS

It is critical NOT to change the ROTARY and REACH axis positions from where they are at this point in the calibration process.

1. Using the soft function keys, move the arm VERTICALLY out of the parking station until you can remove the monument and CAREFULLY attach the GP Hand.
2. Again, use the soft function keys to move the Robot VERTICALLY to 31.1 cm.
3. Measure the distance from the bottom, Delrin surface of the GP Hand to the area of the parking station that makes contact with the latches on the bottom of the hand (when parked). The correct measurement should be exactly 12 inches.
4. If the result is different, then use the soft function keys to VERTICALLY move the arm until 12 inches is measured.
5. If ANY soft key adjustments were made in steps A5 or B4, then proceed to section C. If NO soft key adjustments were necessary, then STOP at this point in the procedure. New calibration factors are not required.





C. RECALIBRATE THE ROBOT

1. From the Robot teaching screen, press 0 then C to allow access to the Calibration screen. Enter the following values:

   VERTICAL.....31.1cm
   REACH.....31.1cm
   ROTARY.....360.0 degrees

   Use the existing values for WRIST, GRIP and SYRINGE by pressing the ENTER key to bypass each selection.

2. Press the RET key (when prompted) to get back to the previous teaching screen level.

3. SAVE the dictionary (with the new calibration factors) onto a new diskette. Use the title: PY-SYSTEM CORE DISK Vx.x for Robot S/N xxxx. Add a date and time and write-protect the disk.

4. Mark the old core disk as OBSOLETE and store it separately from the new disk.

D. DISK MANAGEMENT

With the new core disk loaded and the Controller power cycled:

> *Note: If you were referred to this Py calibration procedure because of service performed on any rotary-axis related problem, then it will be necessary to PYAPPEND, SETUP and TEST each Py section on the benchtop. This will create a new bench configuration diskette to be used in the steps that follow.*

1. APPEND the bench configuration diskette into the dictionary.

2. PYAPPEND the GP Hand PySection that was used in the calibration.

3. SAVE the new dictionary contents onto the bench configuration diskette and re-date the diskette. (This updates the bench configuration diskette with the new calibration factors).

4. Follow steps 1 and 3 for all bench configuration and working diskettes.

   To review the disk management sequence:

   a. LOAD the new CORE DISKETTE.

   b. APPEND the BENCH CONFIGURATION DISKETTE.

   c. SAVE the dictionary contents onto the BENCH CONFIGURATION DISKETTE and all WORKING DISKETTES.

ZYMATE I ROBOT
INITIALIZATION TROUBLESHOOTING GUIDE

FOREWORD

This procedure is intended to be used to repair a Zymate I Robot that fails to initialize. The objective is to identify a faulty subassembly such as a pot, cable, or printed circuit board. Repair at the IC chip level is beyond the scope of this guide.

Most circuitry can be checked with a portable DVM, such as Triplett Model 3550.

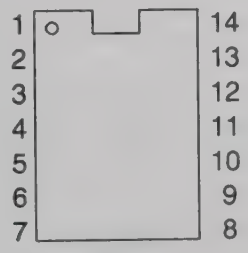
Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate.

GENERAL TROUBLESHOOTING INFORMATION

IC PIN VOLTAGES

In some instances it will be necessary to measure the voltage on designated IC pins. A 14 and/or 16 pin DIP CLIP is a very hand accessory. Work carefully with the meter probe to avoid shorting adjacent pins. IC pin numbering from the TOP of the device is COUNTERCLOCKWISE from PIN 1. PIN 1 is always the first pin COUNTERCLOCKWISE from the NOTCH in one end of the IC. PIN 1 is sometimes also marked with a DOT in the body of the IC.

For example, a 14 pin IC will be numbered:



BACKGROUND:

Robot initialization is the process used by the Robot electronics to determine the POSITION of the Robot's ROTARY, VERTICAL and REACH axes. During initialization, the module board adjusts each of the three position set-points by trial and error until the difference between the set-point voltage and the position potentiometer voltage (error voltage) is small.

The time required for initialization normally ranges from 6 to 50 seconds. This time duration depends upon the physical position of the Robot on system power-up.

The initialization of a Robot verifies that a substantial amount of its electronics is operating properly. Most electronic failures will inhibit initialization.

SYMPTOM:

On system power up, it is not possible to exit the Bench and module setup screen once the Robot teaching screen has been selected.

PROCEDURE 1: LOCALIZE PROBLEM TO ROBOT

1. Turn the Controller's power OFF.
2. Remove the Robot's module card from the Controller.
3. Turn the Controller's power ON.

_____ 4. Verify that the system initializes.

CORRECTIVE ACTION:

If the system fails to initialize, isolate the defective module.

1. Turn the Controller's power OFF.
2. Remove all module cards from the Controller.
3. Plug only the Robot's module card in.
4. Turn the Controller's power ON.

_____ 5. Verify that the Robot will NOT initialize.

CORRECTIVE ACTION:

If the system initializes exclusive of the Robot, AND, the system does NOT initialize with only the Robot plugged in, the problem is most likely in the Robot or its module card.

PROCEDURE 2: INSPECT FOR COMMON FAILURES

A. WRIST COUPLING ACTION

1. Turn the Controller's power OFF.
2. Turn the Robot's power ON.

_____ 3. Verify that when the Robot is turned on, the wrist coupling turns CLOCKWISE then COUNTER-CLOCKWISE before seeking the wrist zero position.

CORRECTIVE ACTION: If it fails to do this:

a. Verify that the Robot has AC power.

b. Check that the coil cord is plugged in at both ends.

c. Confirm the DC power supply voltages.

B. MODULE BOARD INSTALLED CORRECTLY

1. Turn the Controller's power ON.

_____ 2. Verify that the Robot Module is listed on the Bench and module setup screen.

CORRECTIVE ACTION: If the Robot Module is not listed:

a. Confirm that the Robot's module card and the module support board are firmly seated in their respective connectors.

b. Try each in an alternate connector position.

c. Finally, replace the Robot's module card.

C. ROBOT ARM IN NORMAL OPERATING RANGE

Verify that the Robot's arm has not settled inward beyond its zero reach position.

D. ROBOT NOT MOVING

Check that the Robot is not MOVING during initialization.

Example: The vertical axis of the Robot is slowly drifting downward. In order for the Robot's electronics to successfully locate all axes (initialize), there must be no axis movement.

E. COMMUNICATIONS CABLE INSTALLED CORRECTLY

1. Check that the communications cable is firmly plugged in at both ends.
2. Inspect the cable wire colors (LEFT to RIGHT):

   MODULE CARD: white brown green red

   BASEBOARD: green red brown white

3. Inspect the insulation displacement terminations at both cable ends.

F. POT CONNECTORS PLUGGED IN

1. Turn the Controller's power OFF.
2. Remove the Robot's skirts.
3. Check that the ROTARY, VERTICAL, and REACH pots are plugged in.
4. Turn the Controller's power ON.

PROCEDURE 3: CHECK THE POT VOLTAGES ON THE BASEBOARD

1. Turn the Controller's power OFF.
2. Move the Robot to the ZERO rotary, vertical and reach position.
3. Turn the Robot's power ON.
4. Check the pot voltages on the baseboard.
   a. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)
   b. Measure the voltage for each axis at the following locations:

AXIS	TEST POINT
Rotary	**P5 PIN 2 (use hole at connector front)**
Vertical	**R54 (rear-facing lead)**
Reach	**R51 (rear-facing lead)**

5. Verify that each pot's voltage reads approximately 0.4 volts.
6. Move the Robot's arm in each axis and verify that the pot voltage changes.

CORRECTIVE ACTION:

Pot circuit is defective. Replace the respective pot. Refer to R33 REACH POTENTIOMETER , R55 VERTICAL POTENTIOMETER or R87 ROTARY POTENTIOMETER service procedures.

PROCEDURE 4: CHECK THE BASE AND WRIST POWER SUPPLY VOLTAGES

- **There are seven power supply voltages that may be checked with a DVM. Six of these supplies are adjustable.**
- **The baseboard voltages are measured at capacitors C29, C30 and C31 mounted near the right-rear corner of the baseboard.**
- **The wrist board voltages are measured at connector P5 found directly above where the coil cord connects.**
- **Refer to R81 POWER SUPPLY VOLTAGE ADJUSTMENT PROCEDURE for detailed instruction in checking and adjusting these voltages.**
- **Robots built after 8/1/85 have a fixed voltage supply. Refer to the separate, fixed voltage specifications if applicable. If readings do not meet specifications, ignore the Corrective Action section and call Zymark Service.**
- **Set the DVM to Volts, DC, 20V scale.**

A. BASEBOARD POWER SUPPLY VOLTAGES

1. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)

2. Measure the voltage at the (+) end of C31.

_____ 3a. Verify that the voltage reads +13.6 ± 0.1 volt for an adjustable supply.

3b. Verify that the voltage is between +12.9 and ± 14.9 volts for a fixed supply.

CORRECTIVE ACTION:

Adjustment may be made by turning the pot marked +12B on the voltage regulator board.

4. Measure the voltage at the (–) end of C30.

_____ 5a. Verify that the voltage reads –13.6 ± 0.1 volt for an adjustable supply.

5b. Verify that the voltage is between –12.9 and –14.9 volts for a fixed supply.

CORRECTIVE ACTION:

Adjustment may be made by turning the pot marked –12B on the voltage regulator board.

6. Measure the voltage at the (+) end of C29.

_____ 7a. Verify that the voltage reads +5.0 ± 0.1 volt for an adjustable supply.

7b. Verify that the voltage is between +4.7 and +5.3 volts for a fixed supply.

CORRECTIVE ACTION:

Adjustment may be made by turning the pot marked +5B on the voltage regulator board.

B. WRIST BOARD POWER SUPPLY VOLTAGES

1. Remove any hand that may be attached to the wrist.

2. Unplug the wrist MOTOR connector on the underside of the wrist board before checking or setting the wrist power supply voltages.

3. Connect the negative meter lead to the LEFT end of the 2.2 ohm resistor (red-red-gold-gold) on the wrist board. (When facing the front of the wrist box.)

4. Measure the voltage at P5 PIN 1.

From the top side of the board, PIN 1 is marked with a DOT. The rear row contains (left-to-right) pins 1, 3, 5 and 7. The front row, pins 2, 4, 6 and 8.

_____ 5a. Verify that the voltage reads +13.6 ± 0.1volt for an adjustable supply.

5b. Verify that the voltage is between +12.6 and +14.8 volts for a fixed supply.

CORRECTIVE ACTION:

Adjustment may be made by turning the pot marked +12W on the voltage regulator board.

6. Measure the voltage at P5 PIN 4.

_____ 7a. Verify that the voltage reads -13.6 ± 0.1 volt for an adjustable supply.

7b. Verify that the voltage is between -13.0 and -15.2 for a fixed supply.

CAUTION: Do not short out pins 4 and 6.

CORRECTIVE ACTION:

Adjustment may be made by turning the pot marked -12W on the voltage regulator board.

8. Measure the voltage at P5 PIN 5.

_____ 9a. Verify that the voltage reads +8.0 ± 0.1 volt for an adjustable supply.

9b. Verify that the voltage is between +7.4 and +8.8 volts for a fixed supply.

CORRECTIVE ACTION:

Adjustment may be made by turning the pot marked +8W on the voltage regulator board.

10. Measure the voltage at PIN 40 of the 8748.

_____ 11a. Verify that the voltage read +5.0 ± 0.2 volts for an adjustable supply.

11b. Verify that the voltage is between +4.7 and +5.3 for a fixed supply.

CORRECTIVE ACTION:

This voltage is set by a fixed voltage regulator and cannot be adjusted. Voltage exceeding the specified tolerance indicates either a faulty regulator or abnormal circuit current drain.

12. Plug in the wrist motor connector.

PROCEDURE 5: MEASURE THE D/A CONVERTER OUTPUT VOLTAGES

BACKGROUND:

The set-point voltages to the three base servos are supplied from a DA converter consisting of an 8253 counter (U3) and a 4053B CMOS switch (U7). Each section of the counter delivers a 244 Hz signal with a duty-cycle proportional to the desired set-point voltage. Each of these three signals causes a section of the CMOS switch to connect its output to the 5 volt supply for a time proportional to the present counter value. Otherwise, the CMOS switch is connected to ground. This results in a CMOS switch output which has an AVERAGE value equal to the desired set point voltage.

The average value of the CMOS switch output can be read directly with a DVM.

1. Turn the Robot's power ON and the Controller's power OFF.
2. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)
3. Measure the voltage at the pins specified below on U7.

AXIS SIGNAL:	**ROTARY**	**VERTICAL**	**REACH**
U7 PIN:	**15**	**14**	**4**
VOLTAGE:	**0**	**0**	**0**

4. Verify that the voltage at each of these pins reads 0 volts.
5. Position the Robot at ZERO rotary and vertical and 1/4 reach.
6. Turn the Controller's power ON.
7. Immediately after turning Controller power on, verify these *momentary* voltage values:

AXIS SIGNAL:	ROTARY	VERTICAL	REACH
U7 PIN:	15	14	4
VOLTAGE:	1.9	1.3	0.8

CORRECTIVE ACTION:

a. If one or two are different, replace the baseboard. Refer to R76 ROBOT BASEBOARD REPLACEMENT procedure.

b. If all three voltages are different, check the serial communications (see PROCEDURE 8).

PROCEDURE 6: MEASURE THE A/D CONVERTER INPUT VOLTAGES

BACKGROUND:

When the Controller is turned on, each of the 3 set-point voltages moves toward its associated pot voltage value. The initialization search time depends upon the position of the Robot when the search begins. The 3-axis search starts at the same time, but the last one to find its position determines the length of the initialization. The time to search each axis is proportional to the axis resolution and its distance from mid-position. The rotary axis with its high resolution may take as long as 50 seconds, while the other axes may take up to 25 seconds.

1. Turn the Robot's power ON and the Controller's power OFF.

2. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)

_____ 3. Measure the voltage at the pins specified below on the A/D converter (U2).

AXIS SIGNAL:	ROTARY	VERTICAL	REACH
U2 PIN	13	12	15
Controller OFF:	0.1	0.1	0.1

CORRECTIVE ACTION:

Replace the baseboard. Refer to R76 ROBOT BASEBOARD REPLACEMENT procedure.

4. Turn the Controller's power ON.

_____ 5. Verify the voltage at each of these pins:

AXIS SIGNAL:	ROTARY	VERTICAL	REACH
U2 PIN	13	12	15
CONTROLLER ON:	2.1	2.1	2.1
AFTER INIT:	1.1	1.1	1.1

CORRECTIVE ACTION:

a. If the Controller ON values are incorrect, and the voltages measured on U7 incremented to the correct values when the Controller was turned on (see procedure 5, step 7), replace the baseboard. Refer to R76 ROBOT BASEBOARD REPLACEMENT procedure.

b. If the AFTER INIT values are not attained after approximately 1 minute, the A/D converter is probably not working and the baseboard is defective. Check the A/D converter following Procedure 7.

PROCEDURE 7: CHECK A/D CONVERTER OPERATION

1. Turn the Robot's power ON and the Controller's power OFF.
2. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)
3. Set the DVM for 2V DC range.
4. Measure the voltage at U2 pin 4.

_____ 5. Verify that the voltage reads 0.9 – 1.0V (with the Controller OFF).

6. Measure the voltage at this pin when the Controller is turned ON.

_____ 7. Verify that the voltage momentarily drops to ZERO then quickly rises and settles to 1.4 volts. (The AFTER INIT value is 1.2 volts.)

CORRECTIVE ACTION:

The A/D converter is malfunctioning. Replace the baseboard. Refer to R76 ROBOT BASEBOARD REPLACEMENT PROCEDURE.

PROCEDURE 8: CHECK OUT SERIAL COMMUNICATION

BACKGROUND:

Communication between the Robot module board and the Robot base and wrist electronics is accomplished by a low speed, serial communications link. The link's low speed and intensive software error detection facility ensures noise-immune, reliable data transfer.

The software error handling involves data re-transmission until correct data reception is confirmed. Consequentially, data transmission in a noisy environment will appear slow and a failure in the communications link will hang the Zymate System indefinitely.

Data from the Controller (DFC), is interpreted by the module board and then sent to the base or wrist for execution. The base and wrist receive data from the module board only when their unique address has been transmitted. This allows the base and wrist to share one common receive line. Data transmitted to the controller (DTC) from the base (DTCB) and the wrist (DTCW) is gated by I.C. U14 on the baseboard. U14 combines DTCB and DTCW to form DTC, creating a common transmit line for both the base and wrist.

A communications clock signal (SYNC) is provided by the baseboard microprocessor (U1) to both the wrist and module card. Additionally, a fourth wire in the communications cable is a reset line which permits the module card to hard-wire reset the base microprocessor each time the Controller is turned on.

SIGNAL TABLE

SIGNAL:	SYNC	DFC	DTC	RESET
MODULE CARD P2 PIN:	5	1	3	7
COMM CABLE COLOR:	BROWN	RED	GREEN	WHITE
BASEBOARD U14 PIN:	3	4	11	(U1 PIN 4)
WRIST BOARD P5 PIN:	7	8	–	–

1. Turn the Robot's power ON and the Controller's power OFF.
2. Attach the negative meter lead to the baseplate. (One of the skirt mounting brackets is a convenient tie point.)
3. Measure the voltage at the pins specified below on U14.

> Note: The maximum low (L) allowed is +1V
> The minimum high (H) allowed is +3V

U14 PIN:	9	11	4	6	3
STATE:	L	L	H	L	(2V)

IF DIFFERENT ON:

PIN 9

a. If the voltage is HIGH, check the voltage on the wrist board: P5 PIN 6. If it is also HIGH, replace the wrist board. Refer to R46 WRIST BOARD REPLACEMENT.

b. If P5 PIN 6 is LOW, the conductor in the flex circuit or the coil cable to the wrist is open. Check connections. If the coil cable is defective, refer to R22 COIL CORD REPLACEMENT. If the flex circuit is defective, refer to R17 FLEX CIRCUIT REPLACEMENT.

PIN 11 If the voltage is HIGH, replace the baseboard. Refer to R76 ROBOT BASEBOARD REPLACEMENT.

PIN 4

a. If the voltage is LOW, unplug the communications cable at the module card. If the voltage now goes HIGH, the cable was BACKWARDS or the module card is defective.

b. If the voltage remains LOW, unplug the communications cable at the baseboard. If the voltage now goes HIGH, the communications cable is defective.

c. If the voltage remains LOW, unplug the flex circuit cable at the baseboard. If the voltage now goes HIGH, the flex circuit, coil cable or wrist board is defective. Replace the affected part. Refer to R17 FLEX CIRCUIT, R22 COIL CORD or R46 WRIST BOARD REPLACEMENT as necessary. If the voltage remains LOW, replace the baseboard. Refer to R76 ROBOT BASEBOARD REPLACEMENT.

PIN 6

a. If the voltage is HIGH, replace the baseboard (U14). Refer to R76 ROBOT BASEBOARD REPLACEMENT.

PIN 3

a. If the voltage is either HIGH or LOW, replace the baseboard (U1 or U14). Refer to R76 ROBOT BASEBOARD REPLACEMENT.

4. Measure the voltage at the pin specified below on the wrist board.

P5 PIN: 7
STATE: 2V

IF DIFFERENT:

a. If the voltage is either HIGH or LOW, the conductor in the flex circuit or coil cable to wrist is defective. If the flex circuit is defective, refer to R17 FLEX CIRCUIT REPLACEMENT. If the coil cable is defective, refer to R22 COIL CORD REPLACEMENT.

5. Turn the Controller's power ON momentarily while measuring the voltages at the pins specified below:

AT BASEBOARD:

U14 PIN: 4
STATE: 0–2V (fluctuating – Controller communicating)

IF DIFFERENT:

a. If HIGH, DFC (red wire) is open between the baseboard and module card. Replace the communications cable.

AT BASEBOARD:

U1 PIN: 4
STATE: Goes momentarily LOW when Controller is turned ON

IF DIFFERENT:

a. The reset line (white wire) is open between the baseboard and module card, OR, the module card is not issuing the reset. Try replacing the communications cable. If the problem is not corrected, replace the module card.

AT WRISTBOARD:

P5 PIN: 8
STATE: 0–2V (fluctuating – Controller communicating)

IF DIFFERENT:

a. If HIGH, the DFC conductor is open in either the flex circuit or the coil cable. If the flex circuit is defective, refer to R17 FLEX CIRCUIT REPLACEMENT. If the coil cable is defective, refer to R22 COIL CORD REPLACEMENT.

AT MODULE CARD: (remove the communications plug to make measurements)

P2 PIN:	3(Green)	5 (Brown)
STATE:	0–.5V (fluctuating)	2V

IF DIFFERENT:

PIN 3 **a. If 2–3 volts, the green wire is open or the baseboard is defective.**

PIN 5 **a. If 2–3 volts, the brown wire is open or the baseboard is defective.**

If there appears to be an open wire, try replacing the communications cable. If the problem is not corrected, refer to R76 ROBOT BASEBOARD REPLACEMENT.

ZYMATE II ROBOT
INITIALIZATION TROUBLESHOOTING GUIDE

FOREWORD

This procedure is intended to be used to repair a Zymate II Robot that fails to initialize. The objective is to identify a faulty subassembly such as a pot, cable, or printed circuit board. Repair at the IC chip level is beyond the scope of this guide.

Most circuitry can be checked with a portable DVM, such as Triplett Model 3550.

This guide contains the following sections:

GENERAL TROUBLESHOOTING INFORMATION

SECTION I: COMMUNICATION FAILURES

SECTION II: INITIALIZATION FAILURES

PART 1: BASE AXIS TROUBLESHOOTING

PART 2: WRIST AXIS TROUBLESHOOTING

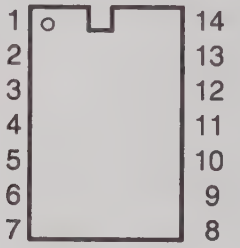
Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

GENERAL TROUBLESHOOTING INFORMATION

IC PIN VOLTAGES

In some instances it will be necessary to measure the voltage on designated IC pins. A 14 and/or 16 pin DIP CLIP is a very handy accessory. Work carefully with the meter probe to avoid shorting adjacent pins. IC pin numbering from the TOP of the device is COUNTERCLOCKWISE from PIN 1. PIN 1 is always the first pin COUNTERCLOCKWISE from the NOTCH in one end of the IC. PIN 1 is sometimes also marked with a DOT in the body of the IC.

For example, a 14 pin IC will be numbered:



BACKGROUND

Robot initialization is the process used by the Robot electronics to determine the POSITION of the Robot's axes. After initialization, the axis drive motors are enabled.

During initialization, the module board adjusts each of the axis set-points until the difference between the set-point voltage and the position potentiometer voltage is small.

The initialization of a Robot verifies that a substantial amount of its electronics is operating properly. Most electronic failures will inhibit initialization. It is an effective electronic SELF-CHECK.

THE SYMPTOM OF FAILURE TO INITIALIZE

Turn the system power ON. Select the BENCH AND MODULE SETUP screen. Select the Zymate II Robot module.

NORMALLY the Robot will initialize after 4 to 14 seconds and the Robot teaching screen will be displayed.

COMMUNICATION FAILURES

Communication failures will cause the display of a diagnostic message. Because of extensive retrying, this message will take up to 90 seconds to appear.

If the message **"FATAL ROBOT COMMUNICATION ERROR TYPE xxx"** appears, then:

REFER TO SECTION 1

INITIALIZATION FAILURES

Initialization failures will also cause the display of a diagnostic message. The message will identify which axes can not be initialized.

If the message **"ROBOT INIT ERROR AXIS: (axis)"** appears, then:

REFER TO SECTION II

OTHER FAILURES

Check that the Robot appears on the BENCH AND MODULE SETUP screen.

If the Robot is MISSING, confirm that the module board and module support board are both firmly seated in their respective connectors. To detect a poor connection, try the module board in an alternate location and try the module support board in another Controller slot. Finally, replace the module board.

If the Robot APPEARS, but the diagnostic message does not, then the problem may be in another module or in the Controller itself. Determine the defective module by unplugging all modules and trying each one at a time until the defective module is isolated.

SECTION I: COMMUNICATION FAILURES

The communication failure diagnostic message will specify a numerical failure type.

TYPE 129

Type 129 means that the Controller serial channel timed-out before the message was sent. This is probably due to loss of the SYNC signal from the wrist. Without SYNC, the UART on the module card can not send its message.

TYPE 130

Type 130 means that a valid RETURN message was not received by the Controller.

With these clues in mind, proceed with the following checks.

A. INSPECT THE FOLLOWING:

1. ROBOT POWER SWITCH ON
2. ROBOT AC POWER CORD CONNECTED (BOTH ENDS)
3. COMMUNICATION CABLE CONNECTED (BOTH ENDS)
4. ANY BASE BOARD LED LIGHTED

   The baseboard LED array near the left-front corner is supplied from the +5 volt base power supply. Normally, the two or three front-most LED's will be ON indicating that the Robot has power.

5. ROBOT COIL CORD CONNECTED (BOTH ENDS)
6. COMMUNICATIONS CABLE INSTALLED CORRECTLY AT MODULE BOARD

   Check the communications cable wire colors (LEFT to RIGHT):

> *Note: Wire color codes should apply in most cases. If your wire colors differ from those below, call Zymark Service for assistance.*

(empty) *(WHITE OR VIOLET)* *(BROWN)* *(GREEN)* *(RED)*

The polarizing cap may be detached from the connector and the connector may be offset by one pin-row or reversed.

7. COMMUNICATIONS CABLE INSTALLED CORRECTLY AT BASE BOARD

Remove the Robot skirts.

Check the communications cable wire colors (LEFT to RIGHT while facing the circuit board):

(GREEN) *(RED)* *(BROWN)* *(WHITE or VIOLET)* *(empty)*

Inspect that the connector is not OFFSET by one pin.

8. CHECK +5 VOLT SUPPLY AT BASE AND WRIST

Refer to the appropriate procedures in section II.

B. SERIAL COMMUNICATIONS

BACKGROUND

Communication between the Robot module board and the Robot base and wrist electronics is accomplished by a serial communications link. The link's intensive software error detection facility insures noise-immune, reliable data transfer.

The software error handling involves re-transmission of data 255 times if correct data reception is not confirmed. Each 32 times during a retry sequence, the Controller resets and reprograms the UART on the module board to correct for possible static discharge resets that could cause the UART to revert to default conditions.

Data from the Controller (DFC), is interpreted by the module board and then set to the base or wrist for execution. The base and wrist receive data from the module board only when their unique address has been transmitted. This allows the base and wrist to share one common receive line. Data transmitted to the Controller (DTC) from the base (DTCB) and the wrist (DTCW) is gated by I.C. U2 on the baseboard. U2 combines DTCB and DTCW to form DTC, creating a common transmit line for both the base and wrist.

The communications clock signal (SYNC) is generated by the wrist microprocessor (U4) to both the base and module boards.

A fourth wire in the communications cable is a reset line permitting the module board to reset the Robot's base microprocessor each time the Controller is turned on.

VOLTAGE MEASUREMENTS - CONTROLLER OFF

With a DVM there are logic level checks that may disclose an open cable conductor or other possible defects.

Refer to the chart on the next page for the correct voltage levels.

Check the voltages at test points TC 1 - 5 near the left-hand edge of the baseboard. Robot power ON, Controller OFF:

SIGNAL	*TEST POINT*	*MEASURED VALUE*
DTC	TC 1	< 0.2
DFC	TC 2	2.0 - 2.5
SYNC	TC 3	2.6 - 3.2
RESET	TC 4	> 4.5
DTCW	TC 5	< 0.9
DTCB	U2 PIN 2	> 3.0

IF DIFFERENT:

Trace the signal to its source to isolate open connectors or defective signal sources.

Remove the communication cable plug polarizing cover to allow making measurements directly on the connector pins. Be careful to correctly insert the connector back into the module board.

The following signal table identifies both ends of all communication signal paths. Refer to this table as required.

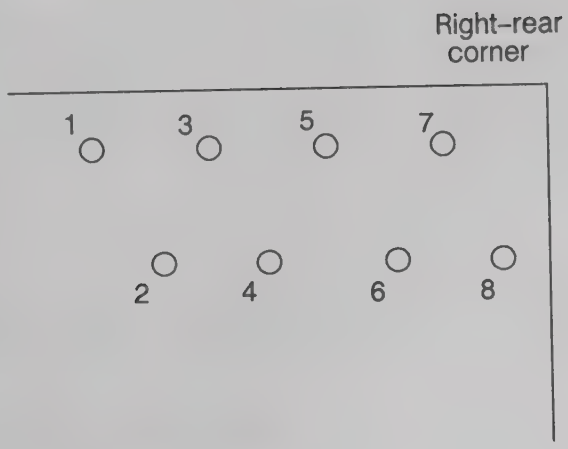
COMMUNICATIONS SIGNAL TABLE

SIGNAL NAME:	*SYNC*	*DFC*	*DTC*	*RESET*	*DTCW*
MODULE BD*: P4 PIN:	5	1	3	7	-
COM CABLE COLOR:	BRN	RED	GRN	WHITE or VIOLET	-
BASE BD: TC PIN:	3	2	1	4	5
WRIST BD: P5 PIN:	7	8	-	-	6

*** Color code will locate pins**

CAUTION: Be careful at wrist connector P5 to avoid shorting adjacent pins together. The pins are covered with a protective layer of insulation. Make voltage measurements by piercing the insulation with a sharp probe.

The pin numbering at P5 is:



VOLTAGE MEASUREMENTS – CONTROLLER ON

For each of the baseboard test points listed below, connect a DVM and observe how the voltage changes when the Controller power is switched ON. Compare with the following descriptions of expected behavior. Do them one at a time and in the order that they are listed.

SIGNAL	*TEST POINT*
RESET	TC 4
DFC	TC 2
DTCW	TC 5
DTCB	U2 PIN 2
DTC	TC 1

RESET

Turn the Controller power ON. The RESET line should go low for about 1 second to reset the base microprocessor. The voltage should then return to the > 4.5 volt level. If OK, proceed to DFC.

If it does not drop, check for the reset signal at the module board P4 PIN 7. If missing, replace the module board.

DFC

Turn the Controller power ON. The DFC line should drop from about 2.3 volts to about 0.5 volts and start to FLUCTUATE. The fluctuation is an indication of signal activity. If OK, proceed to DTCW.

If it does not drop, the DFC line is probably open between the module card and the Robot.

If it drops, but does not FLUCTUATE, then there is no signal activity on the line. Confirm that there is SYNC back at the module board by measuring for 3.0 volts on P4 PIN 5. If there is SYNC, replace the module board. If SYNC is missing, the SYNC line is probably open between the Robot and Controller.

DTCW

Turn the Controller power ON. The DTCW line should FLUCTUATE at least once. The first message sent to the Robot goes to the wrist, so there should be at least one answer from the wrist. If OK, proceed to DTCB.

If the wrist does not answer even once, measure for the DFC and DTCW signals at connector P5 near the right–rear corner of the wrist board.

SIGNAL	*TEST POINT*
DFC	P5 PIN 8
DTCW	P5 PIN 6

The DFC signal should appear exactly as it did on the base board. If it is not present, check that the coil cord is fully seated in its connectors at both ends. The DFC line is probably open somewhere in the coil cord or rotary flex cable.

If the DTCW signal appears at the wrist, but not the base, the DTCW line is probably open somewhere in the coil cord or rotary flex cable.

If the DTCW fluctuation is not seen, try cycling the Robot power once to reset the wrist microprocessor. If the DTCW signal is still not seen, the wrist board should be replaced.

If the wrist board replacement does not fix the problem, the communication from the Controller is possibly so scrambled that the wrist does not recognize a valid message. Replace the module board.

DTCB

Turn the Controller power ON. The DTCB signal should start to fluctuate.

If the DTCB signal never fluctuates, but the DTCW fluctuates until the 90 second timeout, then wrist communication is not being acknowledged by the Controller. Proceed to check the DTC line.

If the DTCB signal never fluctuates, but the DTCW fluctuated ONCE, then the Robot base is not replying. Replace the base board.

If the DTCB signal fluctuates until the 90 second timeout, then the base communication is not being acknowledged by the Controller. Proceed to check the DTC line.

DTC

If DTCB and/or DTCW appear to be responding correctly, the next step is to confirm that the DTC signal is fluctuating.

If it is NOT fluctuating, then either U2 on the base board is defective OR the communications cable is shorted.

If it is fluctuating, then confirm that the DTC signal appears at the module board at P4 PIN 3. If it does NOT, then the DTC line is open. If it does fluctuate, then the line receiver on the module board is probably defective.

If the module card replacement does not fix the problem, it may be that the message is scrambled and not recognized by the Controller. Replace the base or wrist board, depending upon which one is trying to communicate.

SECTION II: INITIALIZATION FAILURES

DETERMINE BASE OR WRIST FAILURE

This section of the troubleshooting guide normally deals with initialization failures resulting in error messages designating axes problems.

Using the axis information provided by the diagnostic message, go to either the BASE or WRIST portion of this section.

BASE AXIS TROUBLESHOOTING

Note: Check that the position pots are plugged in.

MEASURE THE POT VOLTAGES ON THE BASE BOARD

Move the Robot to ZERO rotary, vertical, and reach positions.

Robot power ON, Controller OFF.

Check the pot voltages at TP 1 – 3 on the front edge of the base board.

AXIS	*TEST POINT*	*METER READING*
ROTARY	TP1	0.4
VERTICAL	TP2	0.4
REACH	TP3	0.4

MEASURE THE BASE POWER SUPPLY VOLTAGES

Check the power supply voltages at TV 1 – 5 on the right-hand edge of the base board.

SUPPLY	*TEST POINT*	*METER READING*
–VS	TV5	–19.4 TO –26.6
+VS	TV4	+19.4 TO +26.6
+5	TV3	+4.7 TO +5.3
–13	TV2	–12.9 TO –14.9
+13	TV1	+12.9 TO +14.9

BASE D/A CONVERTER OUTPUT VOLTAGES

BACKGROUND

The set-point voltages to the three base servos are supplied from a D/A converter consisting of an 8254 counter (U9) and a 4053B CMOS switch (U11). Each section of the counter delivers a 224 Hz signal with a duty-cycle proportional to the desired

set-point voltage. Each of these three signals causes a section of the CMOS switch to connect its output to the 5 volt supply for a time proportional to the present counter value. Otherwise the CMOS switch is connected to ground. This results in a CMOS switch output which has an AVERAGE value equal to the desired set point voltage.

The average value of the CMOS switch output can be read directly with a DVM.

With the Robot ON and the Controller OFF, each of the three D/A outputs should read zero volts. Three (3) seconds after the Controller is turned on, the reading should jump to a specified value. The voltage should then change for about 9 seconds until the D/A output voltage EQUALS the pot voltage for its particular axis.

When all axis errors are small, the Controller will signal the base and wrist boards and enable the motors. The Robot may make slight "jump" when the motors are enabled. In most Zymate II Robots this movement is so slight that LED 3 on the base board turning OFF is a more reliable indication. This is also the instant when the Robot teaching screen can be displayed.

CHECK THE ROBOT POSITION

Check that the Robot is still at the ZERO rotary, vertical and reach positions.

MEASURE THE BASE D/A OUTPUT VOLTAGES

Check the D/A converter output voltages at TD 1 – 3 on the front edge of the base board.

Examine the behavior of each of the three voltages. The exact voltages and times are not important.

Use a DVM in a 10 or 20 volt range.

AXIS	*TEST POINT*	*CONTROLLER OFF*	*CONTROLLER 3 SEC*	*ON FOR: 12 SEC*
ROTARY	TD1	0.0	1.9	0.4
VERTICAL	TD2	0.0	1.3	0.4
REACH	TD3	0.0	0.8	0.0

IF DIFFERENT:

If a D/A output fails to jump to the three second value, the circuitry involving U9 and U11 is probably defective. Replace the baseboard.

If a D/A output fails to settle at the expected 12 second value, first check that the Robot is still in the "zero" position. Next, check the pot voltages again at TP 1 – 3. If the pot voltages are correct, continue to the following check for the next level of troubleshooting.

BASE ERROR AMPLIFIER OUTPUT VOLTAGES

BACKGROUND

The error amplifier compares the D/A converter output voltage with the axis position pot voltage to determine positional error in each axis. During the initialization sequence, the error voltage can be measured with a DVM.

MEASURE BASE ERROR AMPLIFIER OUTPUT VOLTAGES

Check the error amplifier output voltages at TE 1 – 3 on the front edge of the base board. Examine the behavior of each of the three voltages. As before, the exact voltages and times are not important.

Use a DVM in a 10 or 20 volt range.

AXIS	*TEST POINT*	*CONTROLLER OFF*	*CONTROLLER 3 SEC*	*ON FOR: 12 SEC*
ROTARY	TE1	0.8	–2.9	0.0
VERTICAL	TE2	0.8	–1.7	0.0
REACH	TE3	0.0	–1.6	0.0

IF DIFFERENT:

Recheck the Robot position.

If the TE3 (REACH) value is wrong with the Controller off, check the voltage on U15 PIN 1. It should be approximately zero. If it is not, then U15 is defective. Replace the baseboard.

If an error voltage has the wrong value with the Controller off, or fails to jump to the proper 3-second value, the error amplifier is probably defective (U13, U14, or U16). Replace the baseboard.

If one error voltage settles to an incorrect final value, the A/D preamplifier (U8) is probably defective. If all three final values are wrong it is probably the A/D converter itself (U6). In either case, replace the base board.

BASE A/D CONVERTER

Check the A/D preamplifier output voltages at the designated pins of U6 on the base board.

Examine the behavior of each of the three voltages. As before, the exact voltages and times are not important.

Use a DVM in a 10 or 20 volt range.

AXIS	*TEST POINT*	*CONTROLLER OFF*	*CONTROLLER 3 SEC*	*ON FOR: 12 SEC*
ROTARY	U6 PIN 15	0.4	2.3	1.2
VERTICAL	U6 PIN 13	1.0	1.7	1.2
REACH	U6 PIN 12	1.2	1.6	1.2

IF DIFFERENT:

If the CONTROLLER OFF or 3 SECOND value is incorrect, the A/D preamplifier (U8) is defective. Replace the base board.

If the 12 SECOND values are incorrect, the A/D converter (U6) is defective. Replace the base board.

WRIST AXIS TROUBLESHOOTING

REMOVE ANY ATTACHED HAND AND RETRY INITIALIZATION

If a wrist axis error is displayed, removing the hand can localize the problem to either the wrist electronics or the hand itself. If the problem still exists after removing the hand and re-initializing, proceed to the next step.

MEASURE THE POT VOLTAGES ON THE WRIST BOARD

Manually move the WRIST coupling counter-clockwise to the ZERO position. If a hand is attached, move the syringe and/or gripper to the fully closed position.

Remove the wrist cover by loosening the four mounting screws about one turn each, raising the cover gently, and folding it back so that it rests upside down on the Robot arm.

Check that the wrist pot is plugged in.

Turn the Controller OFF. Power cycle the Robot (AC switch OFF then ON).

Check the pot voltages as described below. Note that there are different meter readings for Robots with or without hands attached.

For these voltage measurements, connect the meter COMMON lead to the rear terminal in the TV block in the right-rear corner of the wrist board. This is wrist ground. P8 is near the rear edge of the wrist board. Pins are numbered left to right. P6 is in the left-front corner of the wrist board. The connector is numbered CLOCKWISE from PIN 1 because this is the BOTTOM view of an IC-style socket.

AXIS	*TEST POINT*	*METER READING WITHOUT HAND*	*METER READING WITH GRIP HAND*	*METER READING WITH SYR. HAND*
WRIST	P8 PIN 3	4.3	4.3	4.3
SYRINGE	P6 PIN 2	1.8	1.8	4.0
GRIP	P6 PIN 14	1.9	4.1	1.9

IF DIFFERENT:

Refer to the chart below for possible causes and corrective action for the specific voltage readings encountered.

Problem	**Possible Cause**	**Corrective Action**
0V at P8, Pin 3. Also, after initialization, the wrist "runs away" to its mechanical stop and does not respond to move commands from the Robot programming screen facilities.	Defective wrist pot	Replace the wrist pot. Refer to procedure R34 in the Service Manual.
	Open pot connection (Wiper)	Re-solder the wiper connection on the pot.
(con't)		
0V at P8, Pin 3. Also, after initialization, attempting to access the Robot programming screen brings up the prompt: "ROBOT INIT.ERROR AXIS.WRIST".	Defective wrist pot	Replace the wrist pot. Refer to procedure R34 in the Service Manual.
	Open pot connection (+5V)	Re-solder the +5V connection on the pot.

Problem	Possible Cause	Corrective Action
4.9V at P8, Pin 3. Also, after initialization, attempting to access the Robot programming screen brings up the prompt: "ROBOT.INIT.ERROR AXIS:WRIST".	Defective wrist pot	Replace the wrist pot. Refer to procedure R34 in the Service Manual.
	Open pot connection (Gnd.)	Re-solder the Gnd. connection on the pot.
Syringe or grip problems: "Run away" syringes or grips, hands with loss of programmed and manual control, voltage readings different from those listed above.	Defective hand	Hand repair procedures are beyond the scope of this guide, call Zymark Service for assistance.

MEASURE THE WRIST POWER SUPPLY VOLTAGES

The Controller power should still be OFF. Turn the Robot power OFF and then back ON again. This assures that the wrist processor is reset and that the wrist motor is disabled. With the Zymate II Robot it is NOT necessary to unplug the wrist motor to make valid power supply measurements.

REMOVE the HAND from the wrist if one is attached.

Check the power supply voltages at the TV test point block near the right-hand rear corner of the wrist board. The terminals are not numbered due to space limitations. Start at the front test point and work toward the center of the Robot.

For wrist voltage measurements, connect the meter common lead to the rear terminal in the TV block. This is wrist board ground which is typically 0.3 volts above base board ground.

TERMINAL	*METER READING*
FRONT(+5)	+4.7 TO +5.3
(+8)	+7.4 TO +8.8
(+13.6)	+12.6 TO +14.8
(-13.6)	-13.0 TO -15.2
REAR(GND)	(COMMON)

WRIST D/A CONVERTER

BACKGROUND

The set-point voltages to the three wrist servos are supplied from a D/A converter consisting of an 8254 counter (U5) and a 4053B CMOS switch (U6).

With the Robot ON and and the Controller OFF, each of the three D/A outputs should read zero volts. Three (3) seconds after the Controller is turned on, the reading should jump to a specified value. The voltage should then change for about 9 seconds until the D/A output voltage EQUALS the pot voltage for its particular axis.

MEASURE THE WRIST D/A OUTPUT VOLTAGES

> *Note: Before each individual measurement, the Robot should be power cycled to allow for the wrist to reset. (Turn AC power OFF then ON).*

Check that the wrist is still at ZERO and that the hand is either detached OR its grip and syringe settings are zero.

Measure the D/A converter output voltages at the designated pin of U6 on the wrist board.

Examine the behavior of each of the three voltages. The exact voltages and times are not important.

Use a DVM in a 10 or 20 volt range.

AXIS	*TEST POINT*	*CONTROLLER OFF*	*CONTROLLER 3 SEC*	*ON FOR: 12 SEC*
WRIST	U6 PIN 14	0.0	2.1	2.2
SYRINGE	U6 PIN 15	0.0	1.5	2.0
GRIP	U6 PIN 4	0.0	1.5	2.0

If a syringe or grip hand is not attached, the 3-second value should immediately jump to the 12 second value.

IF DIFFERENT:

If a D/A output fails to jump to the three second value, the circuitry involving U5 and U6 is probably defective. Replace the wrist board.

If a D/A output fails to settle at the expected 12 second value, recheck the pot voltages again, and continue on with the following check.

WRIST ERROR AMPLIFIER

BACKGROUND

The error amplifier compares the D/A converter output voltage with the axis position pot voltage to determine how much positional error there is in each axis.

MEASURE WRIST ERROR AMPLIFIER OUTPUT VOLTAGES

Check the error amplifier output voltages at the designated IC pin numbers on the wrist board.

U9, U10, and U11 are on the left-hand side of the wrist board with U9 located nearest the rear.

Examine the behavior of each of the three voltages. As before, the exact times are not important.

Use a DVM in a 10 or 20 volt range.

WITH NO HAND ATTACHED:

> *Note: Before each individual measurement, the Robot should be power cycled to allow for the wrist to reset.*

AXIS	*TEST POINT*	*CONTROLLER OFF*	*CONTROLLER 3 SEC*	*ON FOR: 12 SEC*
WRIST	U9 PIN 7	-4.3	-0.2	0.0
SYRINGE	U10 PIN 7	0.0	1.5	2.0
GRIP	U11 PIN 7	0.0	1.5	2.1

WITH A SYRINGE HAND:

SYRINGE	U10 PIN 7	-4.0	-1.1	0.0

WITH A GRIP HAND:

GRIP	U11 PIN 7	-4.1	-1.1	0.0

IF DIFFERENT:

If an error voltage has the wrong value with the Controller off, or fails to jump to the proper 3-second value, an error amplifier is probably defective. Replace the wrist board.

If all three final values are wrong the A/D converter (U8) is probably defective. If only one final value is wrong, the preamplifier is most likely defective. Proceed to the next measurement.

WRIST A/D CONVERTER

Measure the A/D preamplifier output voltages at the designated pins of U8 on the wrist board.

Examine the behavior of each of the three voltages. As before, the exact voltages or times are not important.

Use a DVM in a 10 or 20 volt range.

> *Note: Before each individual measurement, the Robot should be power cycled to allow for the wrist to reset.*

WITH NO HAND ATTACHED:

AXIS	*TEST POINT*	*CONTROLLER OFF*	*CONTROLLER 3 SEC*	*ON FOR: 12 SEC*
WRIST	U8 PIN 9	2.2	1.3	1.2
SYRINGE	U8 PIN 10	1.2	0.2	0.2
GRIP	U8 PIN 11	1.2	0.2	0.2

WITH A SYRINGE HAND:

SYRINGE	U8 PIN 10	2.2	1.9	1.2

WITH A GRIP HAND:

GRIP	U8 PIN 11	2.2	1.9	1.2

IF DIFFERENT:

If a CONTROLLER OFF or 3 SECOND value is incorrect, an A/D preamplifier (U9, U10, U11) is defective. Replace the wrist board.

If the 12 SECOND values are incorrect, the A/D converter (U8) is defective. Replace the wrist board.

REACH BEARING ADJUSTMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the adjustment of the reach bearings in Zymate I and Zymate II Robots.

PARTS REQUIRED:

NONE

TOOLS REQUIRED:

Screwdriver, blade, 1/8"
Wrench, Allen, .050

OPTIONAL:

Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: ADJUST BOTH BEARINGS

A. POSITION THE ROBOT

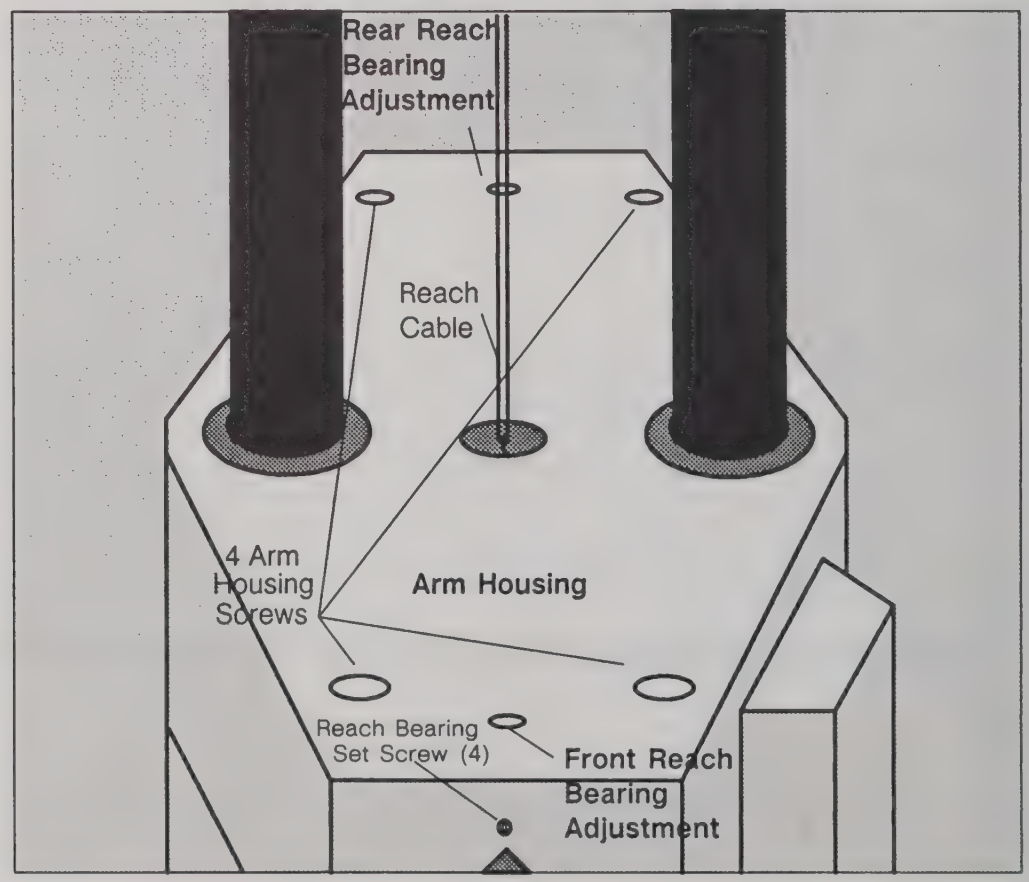
1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Move the arm so that the wrist box is positioned in a convenient location over the benchtop.

> *Note: This location must not have a rotary position value greater than 360 degrees or less than 0 degrees.*

4. Position the arm vertically so that the top of the arm housing is at a convenient working height.

   a. Install a post clamp to temporarily hold the arm housing in this position.

5. Tighten the four screws on the top of the arm housing that hold the two arm housing sections together.



B. ADJUST THE BEARINGS

1. Locate the four set screws that secure the reach bearings.* Two are located on the arm housing just above and below the point where the arm exits from the front of the housing. The other two are located exactly 180° opposite, at the point where the arm exits the rear of the housing.

   ** Robots built prior to 6/88 may not contain the securing set screws.*

2. Using the Allen wrench, loosen (approximately 2 turns) the four set screws.
3. Locate the two small holes on the top of the arm housing for bearing adjustment.
4. Using a small screwdriver, turn the front adjustment screw COUNTER-CLOCKWISE until snug.
5. Turn the screw CLOCKWISE (to loosen) 1/16 to 1/8 turn.
6. Repeat steps 4–5 for the rear adjustment screw.
7. Finally, retighten the four set screws until snug.

C. RECHECK ADJUSTMENT

With the Controller's and Robot's power OFF, manually extend the arm through its full reach.

- *Check for any binding action while moving the arm.*
- *If binding is detected at either end of the reach, readjust the bearings and recheck the adjustment.*

If a binding problem cannot be corrected by bearing adjustment, replace the arm. Refer to R40 ROBOT ARM/REACH BEARING REPLACEMENT.

ROTARY MOTOR SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the DC servo motor which drives the rotary axis.

PARTS REQUIRED:

Rotary motor, P/N 36818
Set screw, 10–32 x 1/2, P/N 38846
Cable tie, 4", P/N 36740

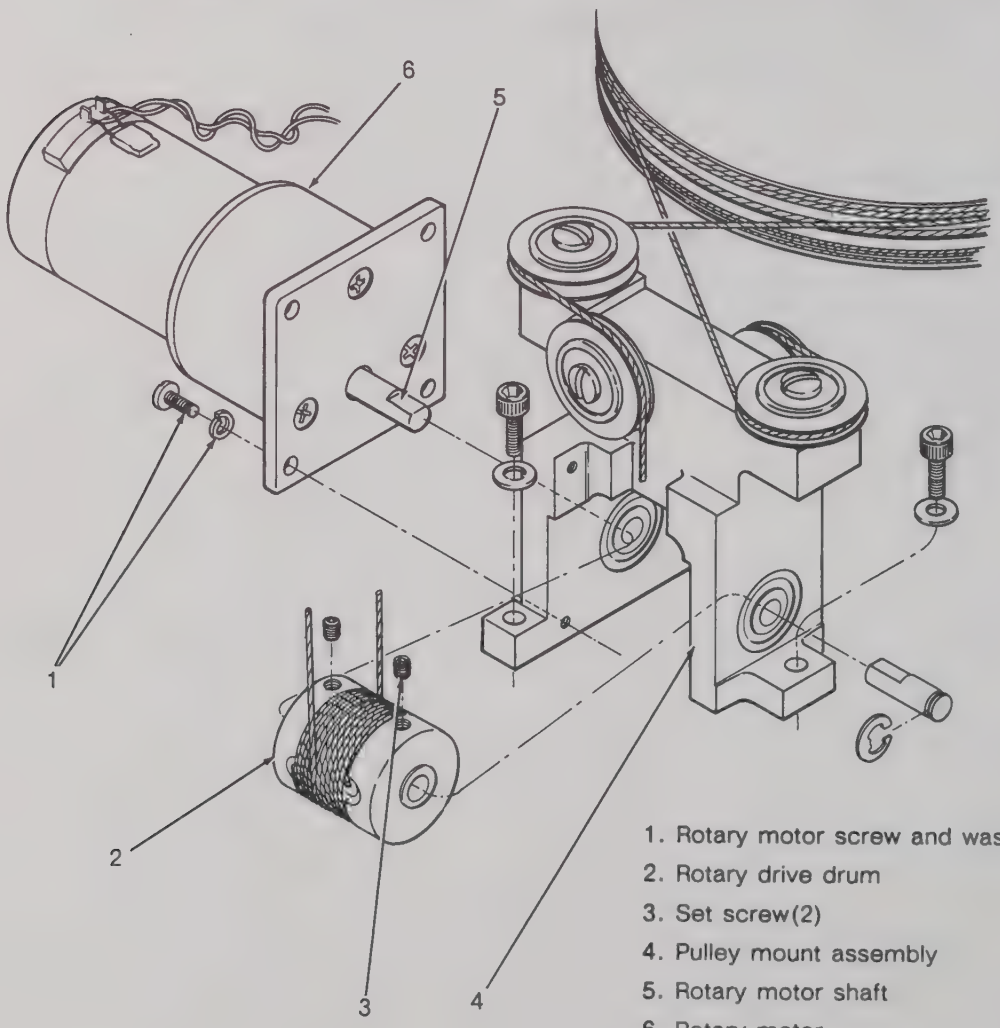
TOOLS REQUIRED:

Screwdriver, blade, 3/16 x 6" min
Screwdriver, blade, 1/4
Screwdriver, holding
Wrench, hex (Allen) 3/32
Wrench, adjustable
Wire cutters (dikes)
Loctite 222®

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

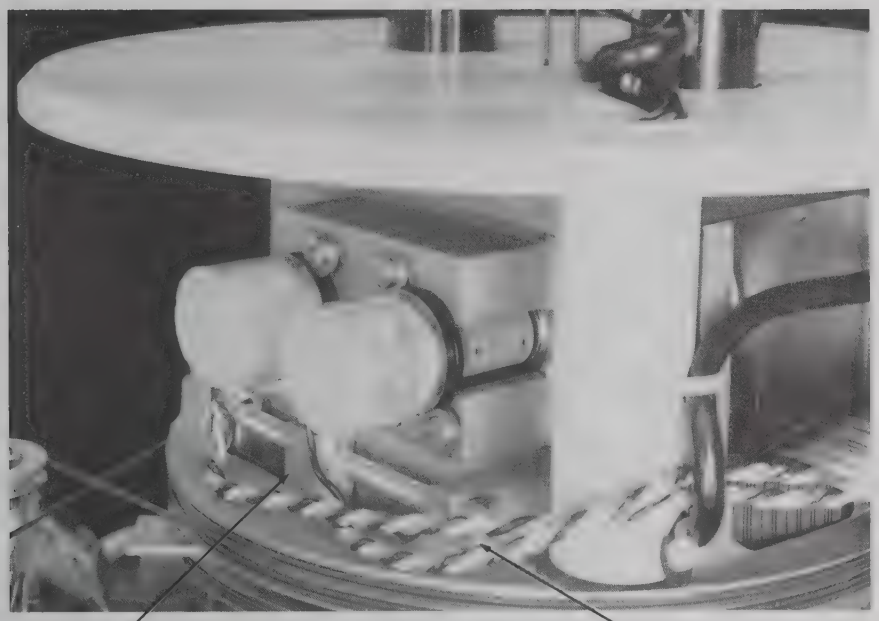
1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and remove the power cord.
3. Remove both skirts.
4. Extend the arm to the maximum reach position.
5. Turn the arm to the 270 degree rotary position.
6. Locate the drive drum on the end of the rotary motor shaft.
7. Continue moving the arm's rotary position until the set screws in the drum are accessible.



1. Rotary motor screw and washer(4)
2. Rotary drive drum
3. Set screw(2)
4. Pulley mount assembly
5. Rotary motor shaft
6. Rotary motor

B. RELAX CABLE TENSION

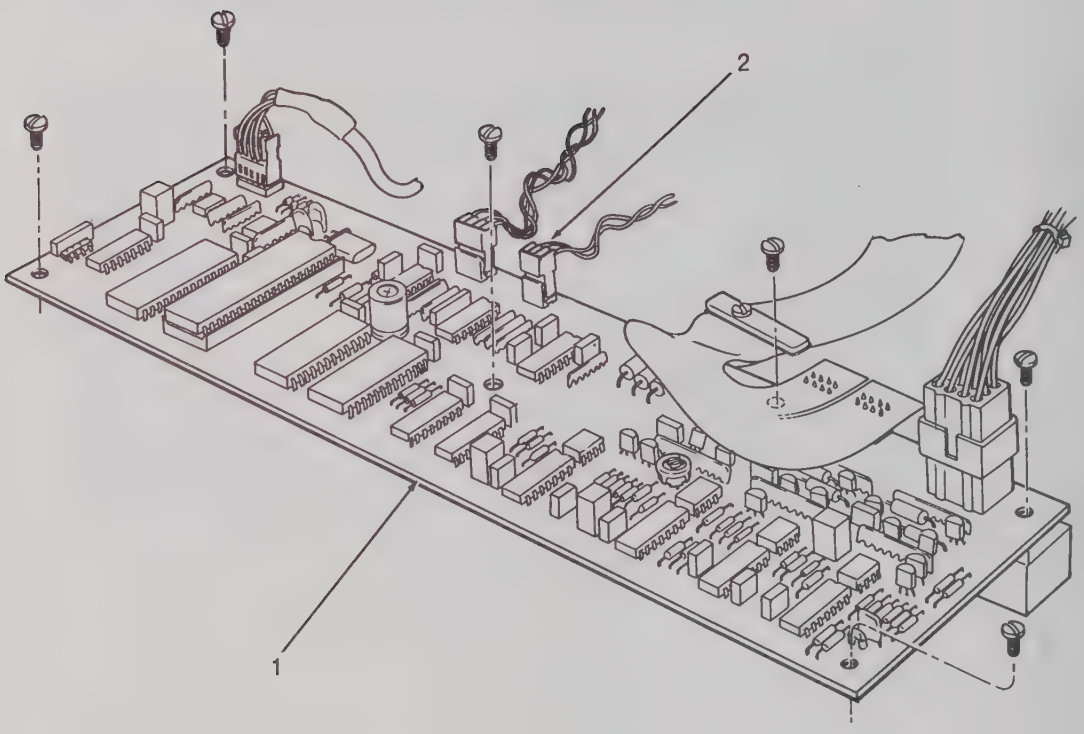
1. Turn the rotary drive cable tensioning screw on the turntable COUNTER-CLOCKWISE 6 turns.



1. Tension adaptor block
2. Rotary cable tensioning screw

C. DISCONNECT THE MOTOR

1. Carefully snip the cable ties securing the motor leads.
2. Unplug the motor leads (orange and purple) at the base electronics board.



1. Robot baseboard
2. Rotary motor cable

D. REMOVE THE MOTOR

1. Remove the set screw nearest the motor in the motor drive drum.
2. Remove the four motor mounting screws.
3. Remove the motor.
    - *It may be necessary to push down gently on the left side of the drive drum while removing the motor.*

PROCEDURE 2: INSTALLATION

A. MOUNT THE MOTOR

1. Position the new motor with the electrical terminals facing UP.
2. Using an adjustable wrench, turn the motor shaft until the flat aligns with the set screw hole in the drum when positioned.
3. Slide the motor into position and secure with the the four mounting screws.

   - *It may be necessary to push down gently on the drive drum to align its center hole with the motor shaft while sliding the motor in place.*
   - *A holding screwdriver is helpful in starting the mounting screws.*

4. Sight through the set screw hole and confirm that the motor flat is aligned with the hole.
5. Apply Loctite 222® to set screw.
   a. Using the Allen wrench, insert the set screw until snug and then loosen 1/4 to 1/8 turn.
   b. With the Allen wrench still in position on the set screw, use one hand to slightly rotate the arm. Use your other hand to hold onto the Allen wrench.
   c. If properly aligned, contact made between the set screw and the shaft flat (as the drum is moved) will stop the drum from rotating more than 10 degrees or so. This contact will also be felt through the Allen wrench.
   d. After verifying alignment in the above manner, fully tighten the set screw against the flat.
6. Install a cable tie securing both sets of leads at the tie point.

B. CONNECT THE MOTOR

1. Dress the motor leads near the pot cable and plug the connector into the base electronics assembly.
2. Install a cable tie securing both sets of leads at the tie point.

C. SET CABLE TENSION

1. Reinsert the Allen wrench into the left drive drum set screw.

   It will act like a "brake lever" during the tensioning operation.

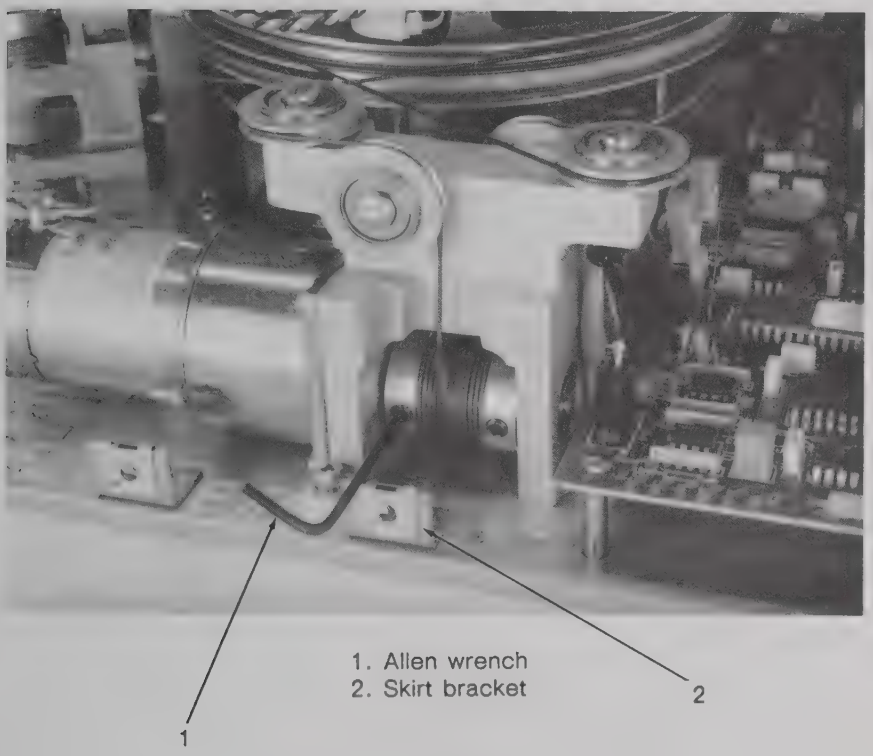
2. Push the wrist box in a CLOCKWISE rotary direction.

   The Allen wrench should move toward the skirt bracket and then stop further drum rotation.

3. Continue pushing the wrist box with about 5 lbs force (at full reach) while tightening the rotary drive cable tensioning screw (located on the turntable block) CLOCKWISE to remove any visible cable slack.

   It MAY require more then 6 turns to achieve proper cable tension.

4. REMOVE THE ALLEN WRENCH.



1. Allen wrench
2. Skirt bracket

D. FINALLY

1. Reinstall the skirts.

VERTICAL MOTOR SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the DC servo motor which drives the vertical axis.

PARTS REQUIRED:

Vertical motor, P/N 36492
Set screw, 10-32 x 1/2, P/N 38846
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, blade, 3/16
Screwdriver, holding
Driver, ball-end hex, 9/64
Wrench, hex (Allen) 3/32
Wrench, adjustable
Wire cutters (dikes)
Loctite 222®

OPTIONAL:

Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

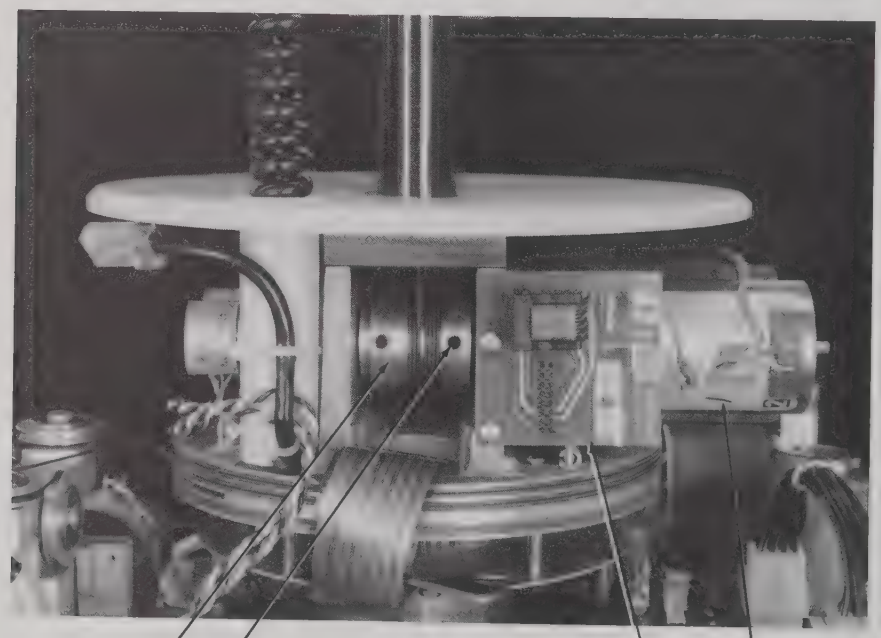
1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and disconnect the power cord.
3. Remove both skirts.

> *Note: Do not position the arm in a rotary location greater than 360° or less than 0°*

4. Turn the arm so that the interconnection board faces you.
5. Locate the drive drum on the end of the vertical motor shaft.

   The vertical motor is the one NEAREST the turntable interconnection board.

6. Move the arm vertically until the set screws in the drum are accessible.
7. Install a post clamp (or other means of support) to support the arm housing in this position.



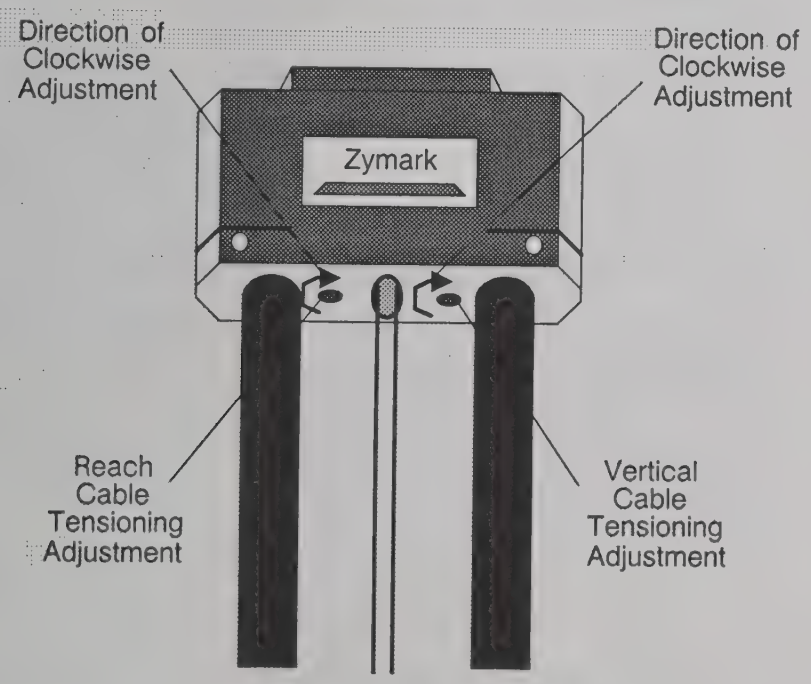
1. Vertical drum
2. Set screw(2)
3. Interconnection board
4. Vertical motor

B. RELAX CABLE TENSION

1. Using a 9/64 ball-end hex driver, turn the vertical drive cable tensioning adjustment CLOCKWISE two turns.

   - *This adjustment is made through a small hole in the BOTTOM SIDE of the column cap assembly at the top of the Robot. The vertical adjustment is the one nearest the post on the interconnection board side.*

   - *CLOCKWISE/COUNTER–CLOCKWISE motion is relative to the end of the screwdriver handle.*



C. DISCONNECT THE MOTOR

1. Snip the cable ties securing the motor leads.

2. Unplug the vertical motor leads at the interconnection board.

D. REMOVE THE MOTOR

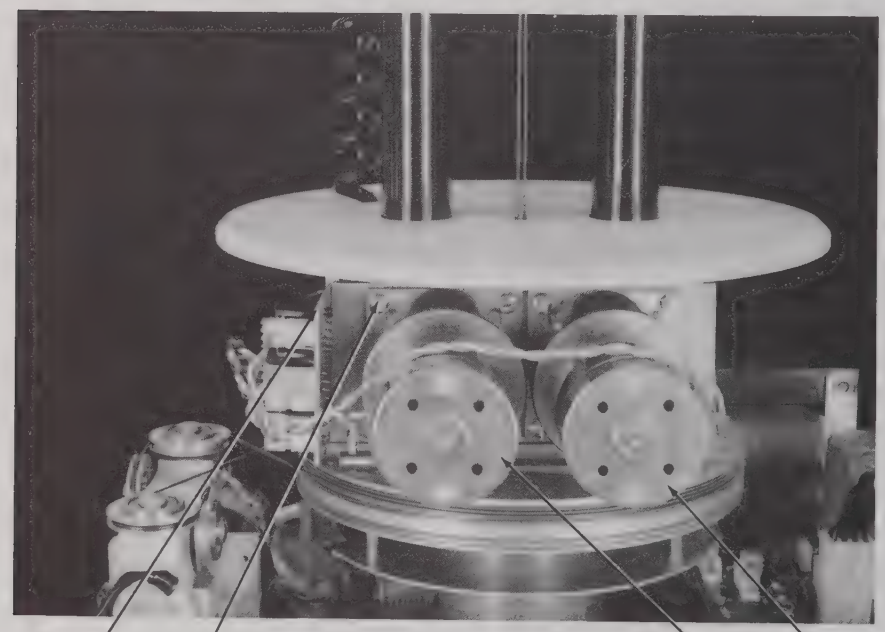
1. Using the Allen wrench, remove the set screw nearest the motor in the drive drum.

   - *It may be necessary to disconnect cables from the interconnection board to gain access to the set screw. (The coil cord connector is released by pressing against a clip behind it with a small screwdriver.)*

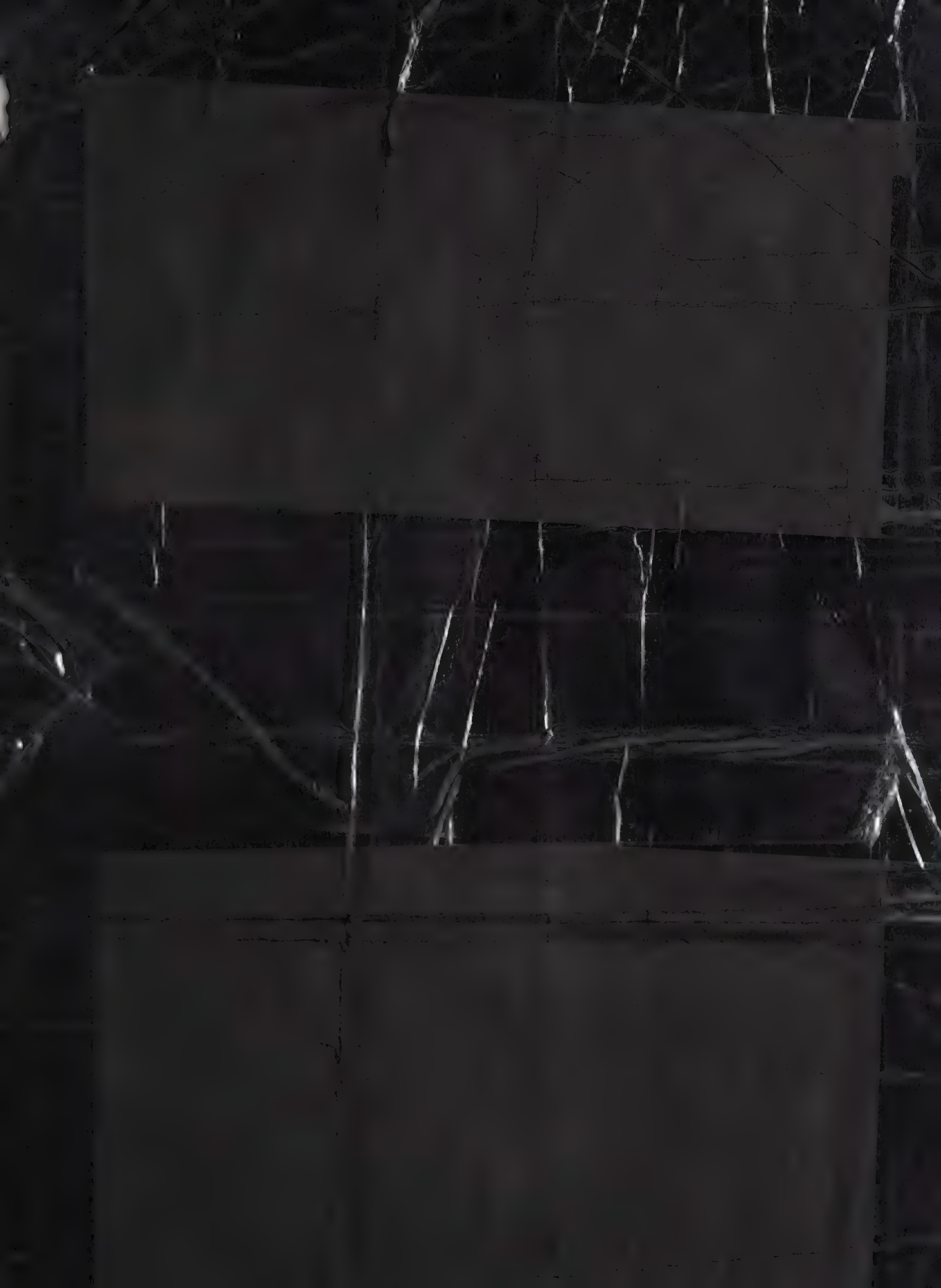
   - *Set screw is held in place with Loctite 222®. It may be necessary to grasp the Allen wrench with two hands to generate enough force to loosen the set screw.*

2. Remove the four motor mounting screws and lockwashers.

3. Remove the motor.



1. Interconnection board
2. Motor mounting screw and lockwasher
3. Vertical motor
4. Reach motor



PROCEDURE 2: INSTALLATION

A. MOUNT THE MOTOR

1. Position the new motor with the electrical terminals to the left. (Motor shaft is pointing away from you.)
2. Using an adjustable wrench, turn the motor shaft until the shaft flat aligns with the set screw hole in the drum when positioned.
3. Slide the motor into position and secure with the four mounting screws and lockwashers.

    - *It may be necessary to push down gently on the drive drum to align its center hole with the motor shaft while sliding the motor in place.*
    - *A holding screwdriver is helpful in starting the mounting screws.*

4. Sight through the set screw hole and confirm that the motor flat is aligned with the hole.
5. Apply Loctite 222® to set screw.
    a. Insert the set screw until snug and then loosen 1/4 to 1/8 turn.
    b. With the Allen wrench still in position on the set screw, use one hand to slightly move the arm housing up. Use your other hand to hold onto the Allen wrench.
    c. If properly aligned, contact made between the set screw and the shaft flat (as the drum is moved) will stop the drum from rotating more than 10 degrees or so. This contact will also be felt through the Allen wrench.
    d. After verifying alignment in the above manner, fully tighten the set screw against the flat.

B. CONNECT THE MOTOR

1. Plug the connector into the interconnection board.
2. Dress both sets of motor leads carefully and install a cable tie.

C. SET CABLE TENSION

Choose one of the following methods for setting correct cable tension:

METHOD #1

1. Remove the post clamp (or other arm housing support means).
2. Turn the vertical drive cable tensioning adjustment (located on underside of column cap) COUNTER-CLOCKWISE (as viewed from handle end) two turns to retension the cable.

METHOD #2

1. Turn the adjustment several turns CLOCKWISE to fully disengage it.
2. Advance the adjustment COUNTER-CLOCKWISE until a slight resistance is felt. This resistance is the FIRST contact between the adjusting screw and the cable-tensioning device within the column cap assembly.
3. Continue to turn the adjustment COUNTER-CLOCKWISE one more turn.

> *Note: Cables should be approximately equal in tension.*

D. FINALLY

1. Reinstall the skirts.

COIL CORD REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the Robot's coil cord cord and support.

PARTS REQUIRED:

Coil Cord, P/N 38446
Coil Cord Guide Assembly, P/N 37483
Cable tie, 4" P/N 36740 (4)
Cable tie, 8" P/N 37745

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8", 3/16"
Screwdriver, Phillips #1
Wire Cutters

OPTIONAL:

Robot post clamp, P/N 38236

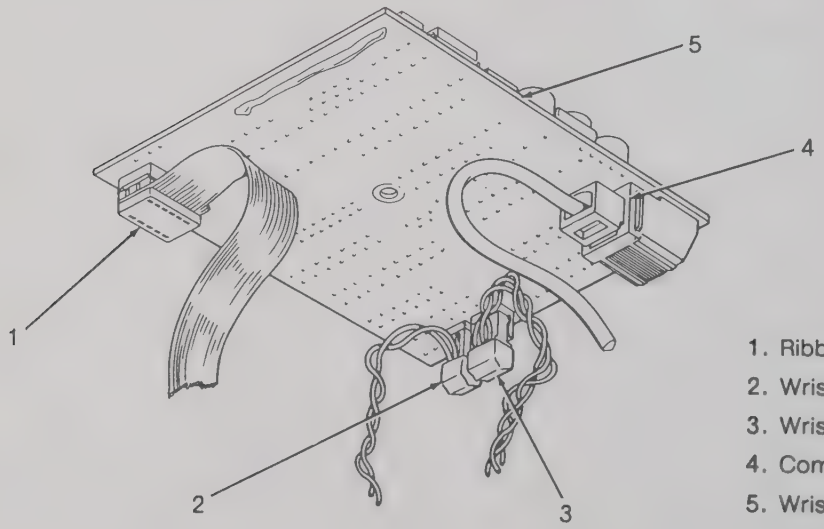
PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Position the arm vertically at half-height.
   a. Install a post clamp to temporarily hold the arm housing in this position.
4. Pull the arm out half way.

B. REMOVE COIL CORD FROM WRIST

1. Loosen (two turns) the four screws that secure the wrist box cover.
2. Carefully lift the wrist box cover and "hinge" it over onto the arm.
3. Remove the wrist board.
   a. Remove the center screw.
   b. Unplug the potentiometer and motor leads.
   c. Using a small flatblade screwdriver, push against the clip at the rear of the coil cord connector to unplug it.
   d. Using a small flatblade screwdriver, pry the ribbon connector on the underside of the wrist board from its socket.



1. Ribbon cable connector
2. Wrist motor connector
3. Wrist pot connector
4. Communication cable
5. Wrist pcb

4. Disconnect the coil cord.

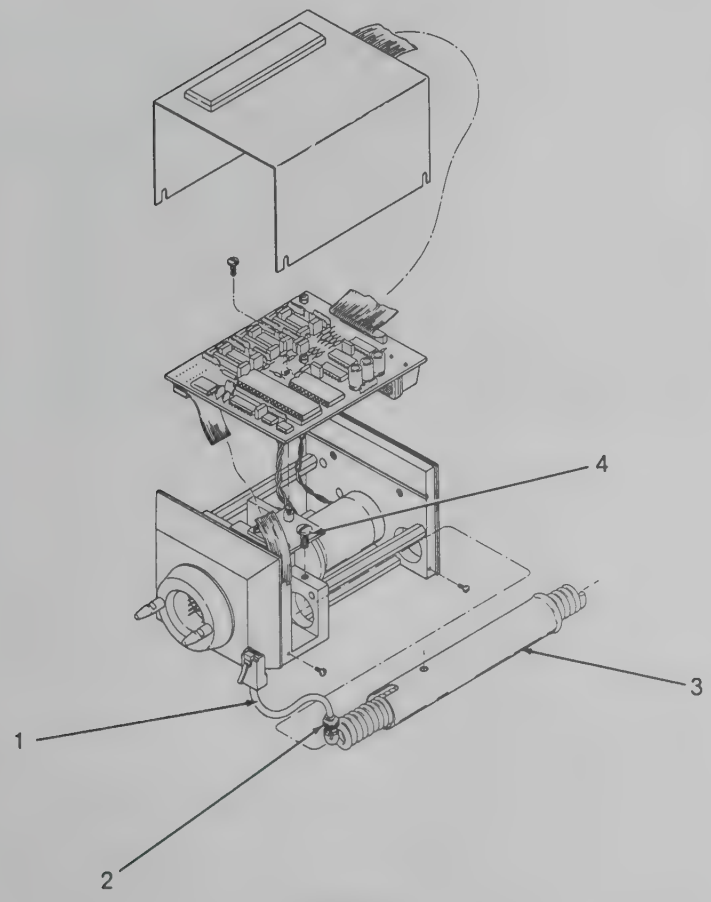
   a. Remove the coil cord tube fastening screw.

   b. Slide the tube from the wrist box.

      Allow the rubber grommet securing the cord in place to slip from its notch in tube to facilitate tube removal.

c. Remove the coil cord from the wrist box.

d. Remove the rubber grommet from the coil cord.



1. Coil cord
2. Rubber grommet
3. Coil cord tube
4. Coil cord tube screw

C. REMOVE COIL CORD FROM ROBOT

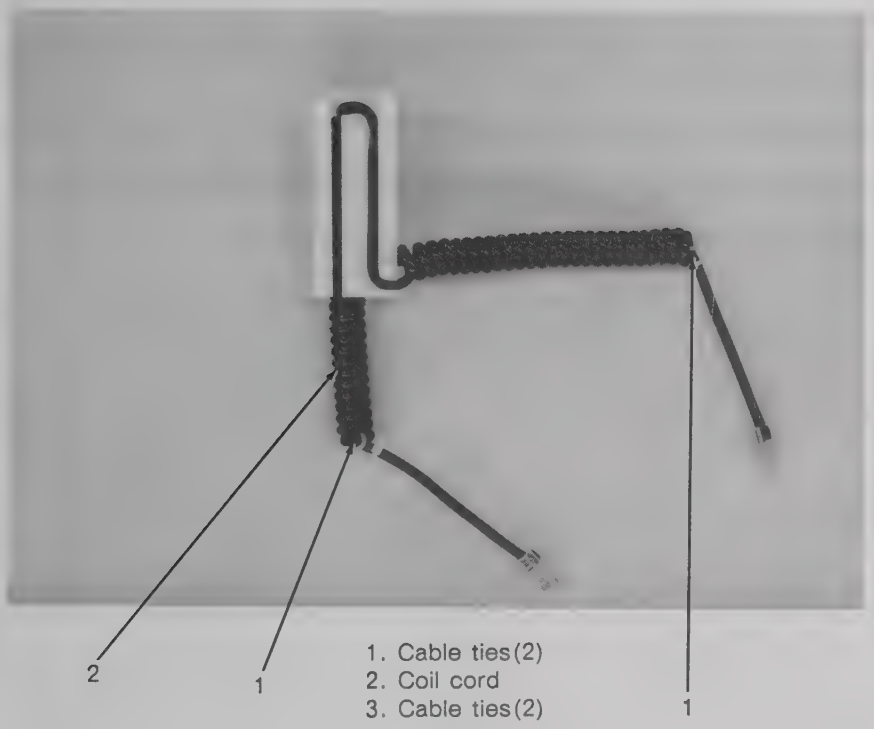
1. Remove both Robot skirts.
2. Unplug the connections to the interconnection board.
   a. Use a small screwdriver to push against the clip on the backside of the coil cord to unplug it.
3. Remove the turntable disk cover containing the coil cord tube.
4. Slide the cord from the turntable cover.

   Allow the rubber grommet securing the cord in place to slip from its notch in the tube to facilitate removal.
5. Set the turntable disk cover aside.
6. Using a Phillips screwdriver, remove the coil cord support from the arm housing.
7. Remove the rubber grommet from the coil cord.

PROCEDURE 2: INSTALLATION

A. PREPARE THE COIL CORD

1. Prepare BOTH ends of the coil cord as illustrated.



a. Use two cable ties on each end.

b. Adjust the tail end length to 3 1/4".

c. The second cable tie should be about a grommet's width away from the first tie.

B. PLACE THE COIL CORD IN THE SUPPORT ASSEMBLY

1. Fold the cord exactly in half.
2. Grasp the center turn and feed the vertical guide rod on the coil cord support through the center turn and into the left section of the coil cable.

> *Note: Some coil cord guides do not have a vertical guide rod as part of the assembly. If yours does not, grasp the center turn of the coil and feed it through the coil cord guide cavity until the center turn reaches the top of the channel. Proceed with step 3.*

3. Unwrapping from the right section, lay the cord into the cord guide channel.
4. Wrap the remaining right section over the horizontal guide rod.
5. Secure the coil cord support to the arm housing.

C. REPLACE COIL CORD IN WRIST

1. Slide the coil cord tube over the coil cord.
2. Feed the coil cord connector into the wrist box.
3. Slip the rubber grommet over the coil cord between the cable ties.
4. Slide the coil cord tube into position in the wrist box.

   Notch in tube should capture grommet.
5. Secure the tube in position with the screw.

D. REPLACE COIL CORD IN ROBOT

1. Slide the coil cord through the turntable cover.
2. Slip the rubber grommet over the coil cord between the cable ties.
3. Capture the grommet in its notch to secure the coil cord.
4. Run the cord up the side of the guide tube and then across to the interconnection board.
5. Using the 8" cable tie, secure the cord to the guide so that the portion of the cord that goes to the circuit board is horizontal.
6. Reattach the turntable cover.

PROCEDURE 3: REASSEMBLE ROBOT

1. Connect the cables to the interconnection board.
2. Reinstall the Robot skirts.
3. Reassemble the wrist:
   a. Plug the four connectors into the underside of the wrist board.
   b. Secure the board in the wrist box with its screw.
   c. If necessary, plug the cable from the cover electronics board into the wrist board.
   d. Secure cover in place and tighten the four screws.

ROTARY SERVO CABLE REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure describes the removal and installation of the rotary servo cable for Zymate I and II Robots.

PARTS REQUIRED:

Rotary servo cable (2) P/N 36529
Cable tie, 4" P/N 36740

TOOLS REQUIRED:

Screwdriver, flatblade
Driver, ball-end hex, 9/64
Wrench, Allen, .050, 3/32
Screwdriver, Phillips, #1
Tweezers or needlenose pliers
Wire cutters
Digital Voltmeter (DVM)
Masking tape

OPTIONAL:

Robot post clamp, P/N 38236

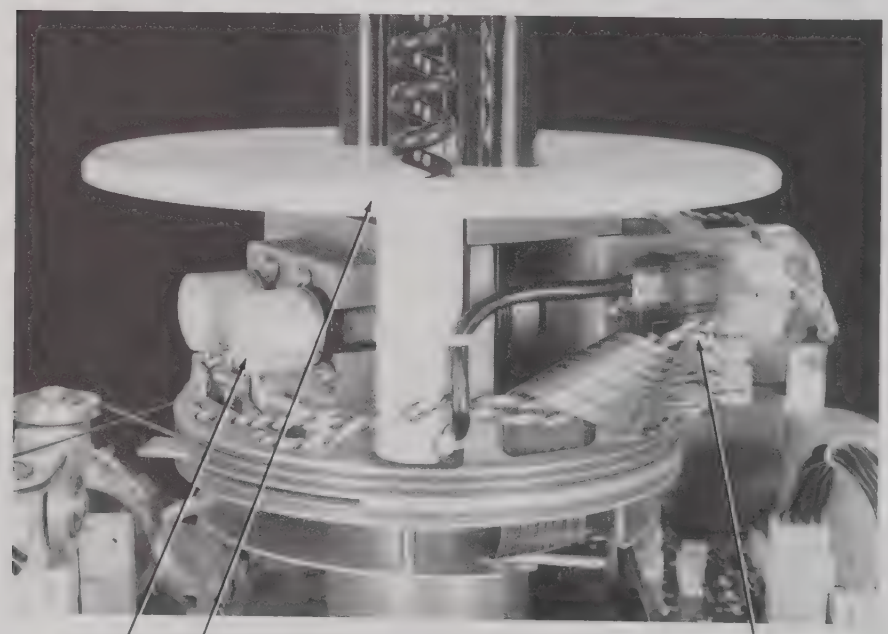
Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Move the arm vertically to mid-height. Install a post clamp (or other means of support) to hold the arm housing in this position.
4. Using a flatblade screwdriver, remove both skirts.
5. Unplug the coil cord from the interconnection board by pressing against the clip on the backside of the connector with a small screwdriver.
6. Using a flatblade screwdriver, remove the turntable cover containing the coil cord tube. Snip any cable ties securing wires to the cover or coil cord.
7. Tape the loose turntable cover to the wrist.

> *Note: Carefully handle the turntable cover so that no turns are ADDED or SUBTRACTED from the coil cord as the cover is removed and reassembled.*



1. Vertical potentiometer
2. Turntable cover with coil cord tube
3. Interconnection board

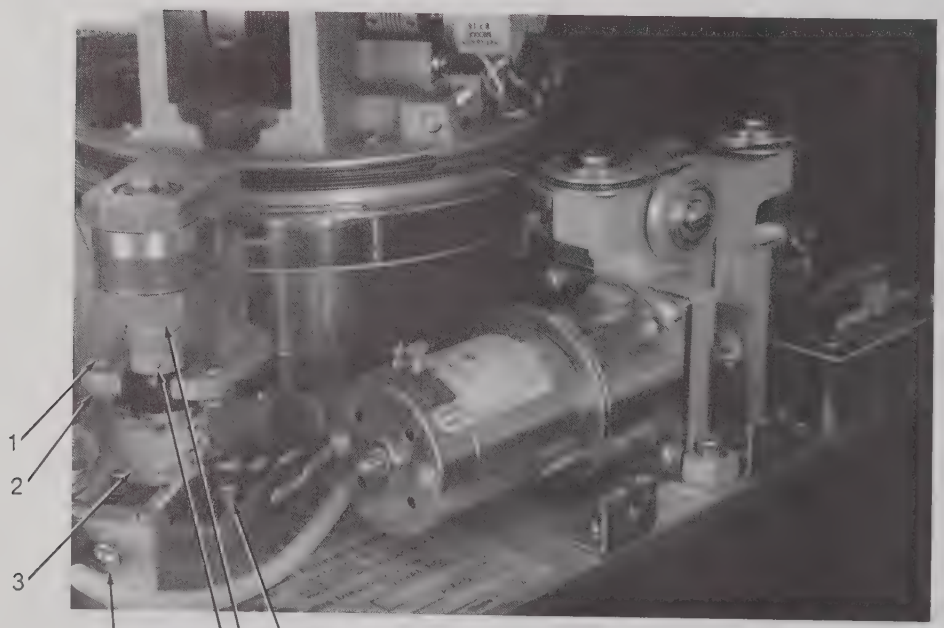
B. REMOVE THE INTERCONNECTION BOARD

1. Disconnect the potentiometer, motor leads and flex cable from the interconnection board.
2. Remove the two screws securing the interconnection board to the turntable and set the screws and board aside.
3. Remove the remaining turntable cover.

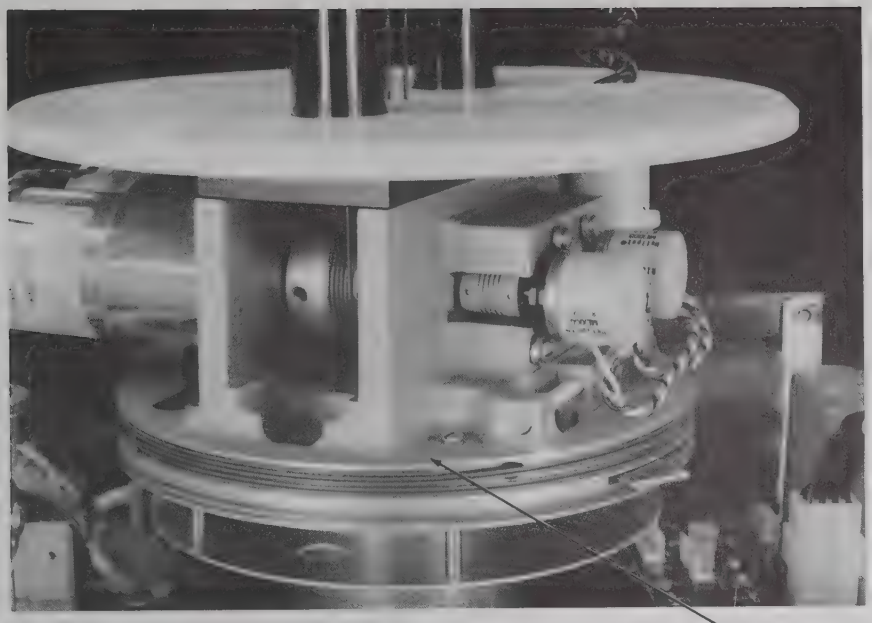
C. REMOVE THE CABLES

1. Using the 9/64 ball-end hex driver, loosen the two Allen heads that secure the rotary pot assembly to the base.
2. Turn the servo cable adjustment screw COUNTER-CLOCKWISE until the rotary pot assembly moves as close as possible to the turntable (approximately 3-4 turns).
3. Using the .050 Allen wrench, loosen the two servo cable set screws approximately two turns.

> *Note: One set screw is located near the reach potentiometer, the other is located 180 degrees opposite beneath the interconnection board. Refer to the photos for details.*



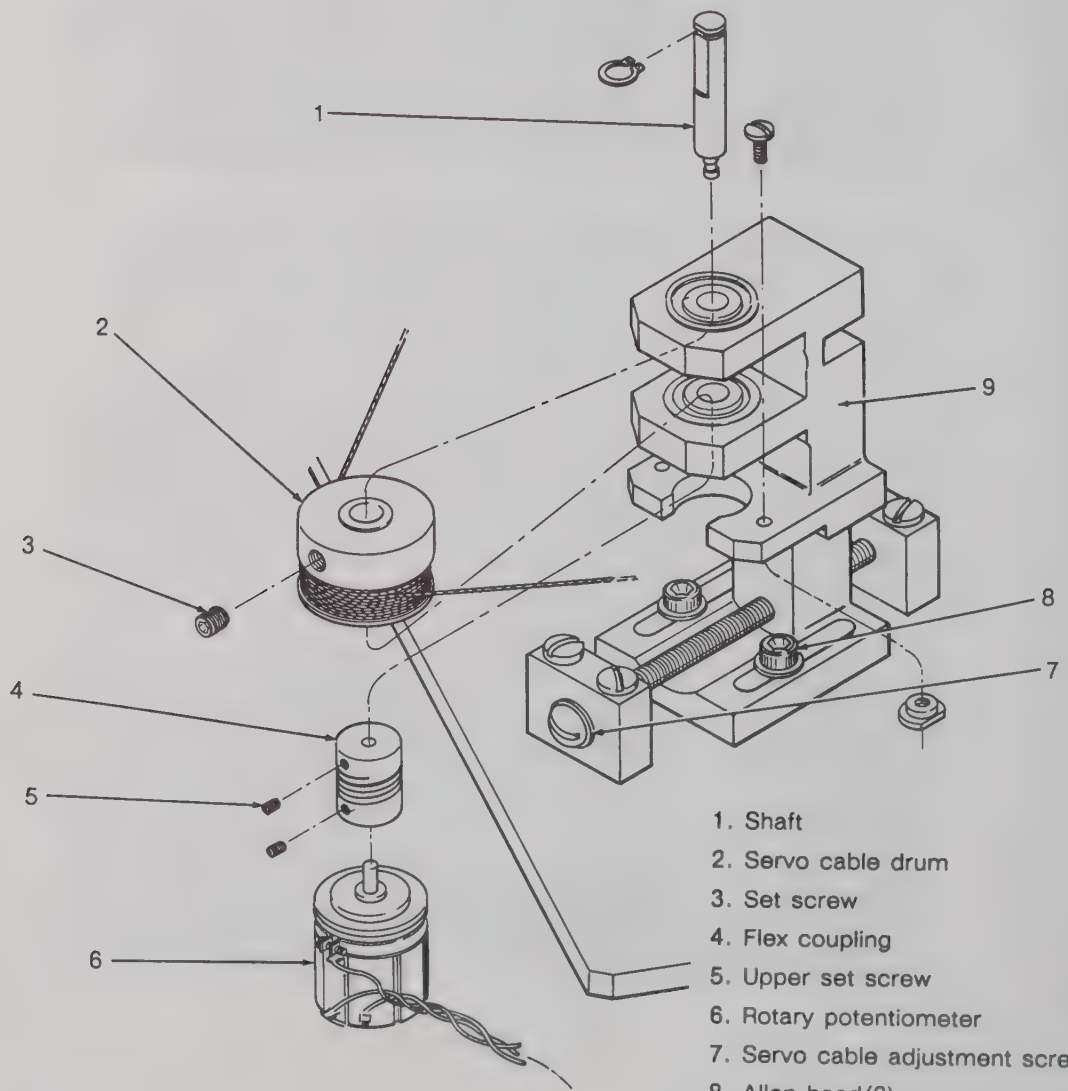
1. Adjustment screw(2)
2. Cleat(2)
3. Rotary potentiometer
4. Set screw
5. Servo cable adjustment screw
6. Rotary pot assembly
7. Allen head(2)



1. Servo cable set screw

1. Servo cable set screw

4. Using tweezers or needlenose pliers, remove the cable ends from the turntable.
5. Unwind the cables from the turntable.
6. Using the 6/32 Allen wrench, remove the set screw in the servo cable drum and set aside.
7. Loosen the UPPER set screw on the flex coupling.
8. Lift the shaft out of the top of the drum using the needlenose pliers.
9. Slide the cable drum from the rotary pot assembly.
10. Unwind and remove both cables from the drum.



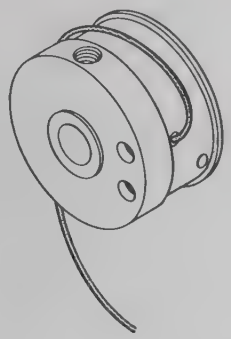
1. Shaft
2. Servo cable drum
3. Set screw
4. Flex coupling
5. Upper set screw
6. Rotary potentiometer
7. Servo cable adjustment screw
8. Allen head(2)
9. Rotary pot assembly

PROCEDURE 2: INSTALLATION

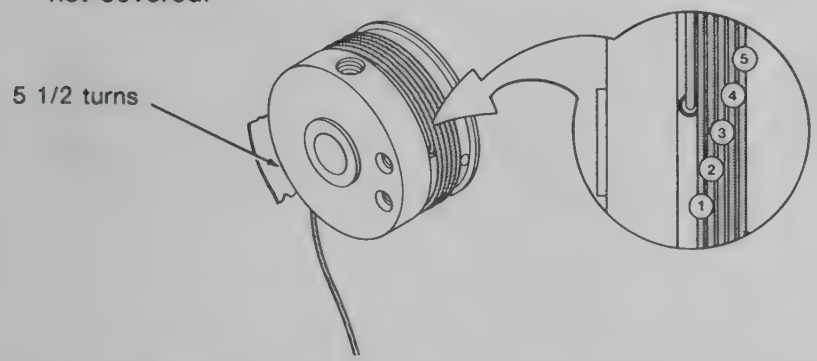
A. REPLACE THE CABLES

Prepare two lengths of tape 5/8" long prior to proceding with the following steps.

1. Insert one of the cables into the hole nearest the wide shoulder of the drum. Use the .050 Allen wrench to tighten the set screw that anchors the cable in place.
2. Holding the drum with the wide shoulder to the left, wrap the cable UP and OVER the drum 5 1/2 turns. Use the ferrule hole in the drum as the reference point when wrapping.

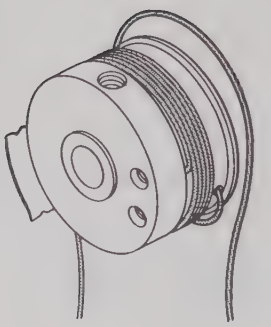


3. Secure the cable to the drum with tape, making sure the right side of the drum is not covered.

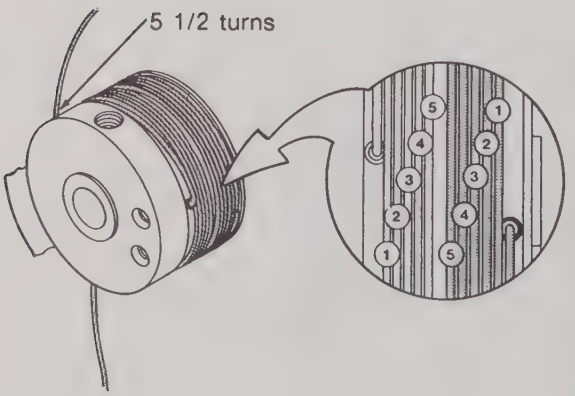


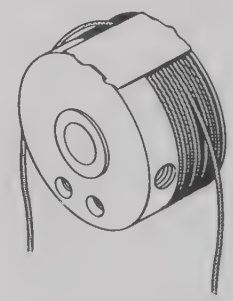
4. Insert the second cable into the remaining hole in the right side of the drum and tighten its set screw.
5. Holding the drum in the same manner as in step #2, wrap the second cable DOWN and UNDER the drum 5 1/2 turns. As before, use the ferrule hole as a reference point.

> *Note: It is necessary to remove the piece of tape securing the first cable to the drum before performing the next step. Hold the cables in place on the drum with your finger to insure correct wrapping.*



6. Secure both cables to the drum with a piece of tape run across the cables 180 degrees opposite the ferrule holes. If correctly placed, both cable ends will be equal in length. Make sure that the tape does not extend to the flat surfaces on the top and bottom of the drum.



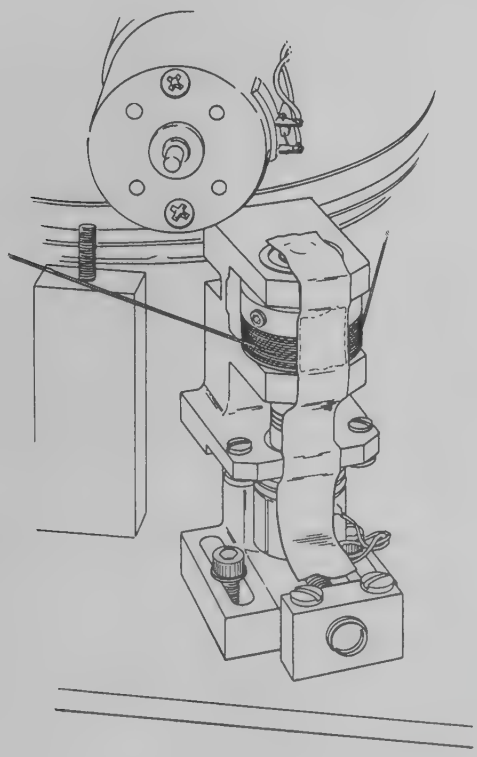


7. With the piece of tape facing away from the turntable and the wide shoulder at the top, insert the wrapped drum into the rotary pot assembly.
8. Insert the shaft through the bearing and drum, lining up the flat of the shaft with the set screw hole on the side of the drum.
9. Install the set screw against the shaft flat.
10. Tighten the top set screw of the flex coupling.

B. WRAP THE BOTTOM CABLE AROUND THE TURNTABLE

Manually move the arm to the 180 degree position to perform the following steps.

1. To prevent the drum from turning, place a 3–4 inch piece of tape across the top of the rotary pot assembly and down the front of the drum (over the tape used in section A, step 6), finally securing to the flex coupling beneath the drum.



2. Wrap the cable that is hanging from the left side of the drum CLOCKWISE around the bottom groove of the turntable approximately 1 3/4 turns. Wrap the cable from the top down. If helpful, use small pieces of tape to secure the cable in place while wrapping.

3. Insert the cable ferrule into the turntable so that its end is flush with the outside surface of the turntable. Secure the cable in place by tightening the set screw with the .050 Allen wrench.

4. While holding the drum securely in place within the rotary pot assembly, manually rotate the turntable CLOCKWISE until all cable slack is removed.

5. Push the wrapped cable down towards the bottom section of the groove. This will allow sufficient room in the upper half of the groove for wrapping the second cable.

C. WRAP THE TOP CABLE AROUND THE TURNTABLE

1. Wrap the second cable to the right and COUNTER-CLOCKWISE around the upper half of the bottom groove appoximately 1 3/4 turns. Wrap the cable from the middle up. Again, use small pieces of tape to secure the cable in place while wrapping.

2. Insert the cable ferrule into the turntable so that its end is flush with the outside surface of the turntable. Secure the cable in place by tightening the set screw using the .050 Allen wrench.

PROCEDURE 3: ADJUSTMENT

A. CABLE ADJUSTMENT

1. Tighten the cables by turning the servo cable adjustment screw CLOCKWISE (moves rotary pot assembly away from turntable) until all slack is removed.
2. Remove all tape from the rotary pot assembly and drums.
3. Reassemble the Robot:
   a. Reattach the interconnection board.
   b. Connect the cables to the interconnection board.
   c. Reinstall the turntable covers.
   d. Ty-wrap cables if applicable.
4. Slowly, rotate the Robot through its rotary axis (manually), and verify that the servo cables operate smoothly as rotation is occuring.
5. Adjust cable tension by grasping either section of the cable between the turntable and the rotary pot assembly and pull sideways. A force of approximately 2 lbs should move the cable .15 to .20 inch.
6. Once cable tension is correct, use the 9/64 ball-end driver to tighten the two screws on the bottom of the rotary pot assembly.

B. POSITION ADJUSTMENT

With the Controller and Robot power OFF:

1. Carefully rotate the arm to the 0 degree position.
2. Connect the DVM:
   a. "+" lead to the pot wiper (black wire)
   b. "-" lead to one of the skirt brackets.
3. Turn just the Robot's power ON.
4. If necessary, adjust the voltage to 0.41 volts:
   a. Using the .050 Allen wrench, loosen the top set screw of the flex coupling.
   b. Rotate the coupling until 0.41 volts is reached.
   c. Retighten the set screw.
5. Disconnect the DVM.
6. For final zero adjustment of the rotary pot, refer to R87, PROCEDURE 3.

REACH POTENTIOMETER SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the precision potentiometer which determines the reach position of the Zymate Robot.

PARTS REQUIRED:

Reach potentiometer, P/N 36847
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

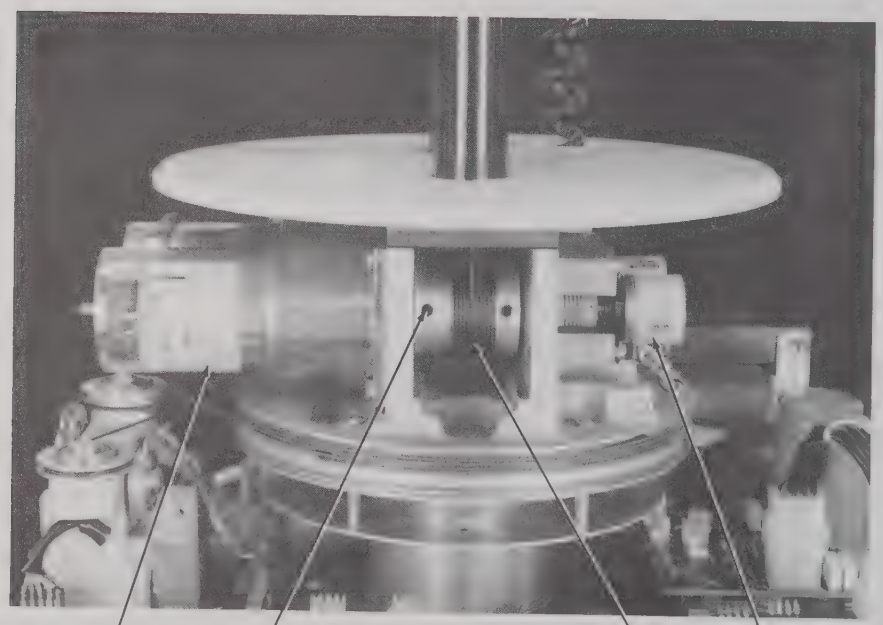
Screwdriver, blade, 1/4"
Wrench, hex .050 (Allen)
Wire cutters
Digital voltmeter (DVM)

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

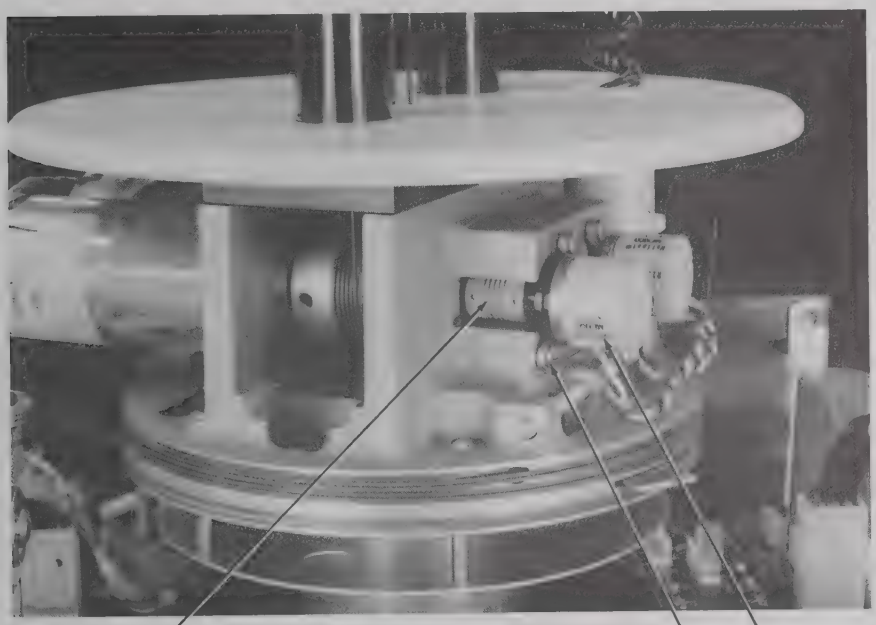
1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Remove both skirts
4. Position the turntable with the motors extending to your left.
5. Push the wrist box inwards until there is a 1" gap between the arm housing and the back of the wrist box.



1. Reach motor
2. Set screw(2)
3. Reach drum
4. Reach potentiometer

B. UNFASTEN THE POT

1. Locate the reach position pot and its flexible shaft coupling.
2. Loosen the coupling set screw NEAREST the pot one turn. Move the Robot's arm slightly if required to access the set screw.
3. Loosen both pot adjusting screws so that the cleats can be turned with the flat FACING THE POT and retighten the screws.



1. Flex coupling
2. Cleat and adjustment screw(2)
3. Reach potentiometer

C. REMOVE THE POT

1. Draw the pot outward.
2. Carefully snip the cable tie with wire cutters.
3. Unplug the pot from the interconnection board.
4. Unplug the reach motor leads from the interconnection board.

PROCEDURE 2: INSTALLATION

A. CONNECT THE POT

1. Plug the new pot into the interconnection board.

> *Note: Do not slide the pot into its flexible coupling at this time.*

2. Dress the pot leads with the vertical pot leads.

B. SET THE POT

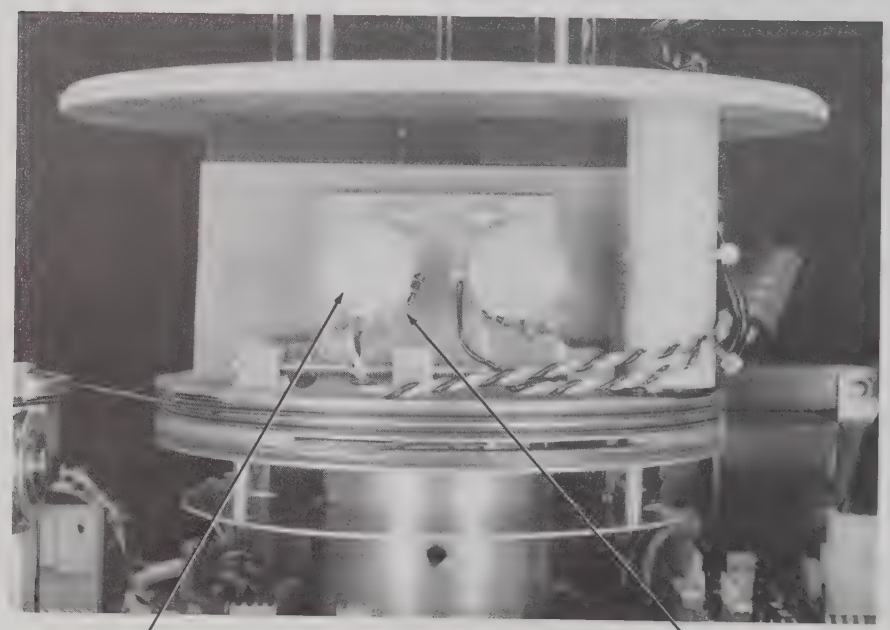
1. Connect a digital voltmeter (DVM).
   a. "+" lead to S pot wiper (black wire).
   b. "–" lead to base plate.
2. Set the DVM to: Volts, DC, 2V scale.
3. Position the pot with its terminals clear of other objects so its shaft can be easily turned.

> *Note: Make sure that the 1" gap still exists between the arm housing and wrist box.*

4. Turn ONLY the Robot's power ON.
5. Turn the pot shaft until the DVM reads 0.43 volts.
6. Turn the Robot's power OFF.
7. Disconnect the DVM.

C. FASTEN THE POT

1. Position the pot body with its terminals in the 4 o'clock position. (See photo below for recommended positioning.)
2. Being CAREFUL to avoid turning the pot shaft, slide the pot into its coupling and gently work it into position.
3. Loosen both adjusting screws and turn the cleats to engage the flange at the front of the pot body.
4. Tighten both adjusting screws until JUST snug.
5. Tighten the coupling set screw.
6. Install a new cable tie.
7. Check that the pot leads are neatly dressed.
8. Plug the reach motor leads into the interconnection board.



1. Reach potentiometer
2. Reach potentiometer terminals

PROCEDURE 3: POSITION ADJUSTMENT

Loosening the adjustment screws allows the pot body to be turned, changing the Robot's reach position. This adjustment may be used to:

- Set the reach positiion at ZERO; or,
- Reset the reach to a previously NAMED location to minimize the need for reprogramming after a pot change.

A. ZERO ADJUSTMENT

1. Turn the Robot and Controller's power ON.
   a. Wait for the system to initialize.
2. Use the Robot's teaching screen to move Robot to ZERO reach.
3. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
4. By rotating the pot body, move the arm until the space between the rear surface of the wrist box and the front face of the arm housing is 0.9 inch.
5. Retighten the adjusting screws until JUST snug.

B. NAMED LOCATION ADJUSTMENT

1. Turn the Robot and Controller's power ON.
   a. Wait for the System to initialize.
2. Use the Robot's teaching screen to move Robot to a NAMED location.
   - *A convenient location is usually a hand attach position. Remove the hand from the station. Move to the park position. Move the vertical UP enough to install the hand on the wrist. The hand should be just over the parking station and by looking vertically downward, the reach error can be judged.*
3. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
4. Move the arm to the desired position by rotating the pot body.
5. Retighten the adjusting screws until JUST snug.

C. FINALLY

1. Turn the Zymate Controller's power OFF.
2. Turn the Robot's power OFF.
3. Reinstall the Robot skirts.

WRIST POTENTIOMETER SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the precision potentiometer which determines the wrist angle of the Zymate Robot.

PARTS REQUIRED:

Wrist potentiometer, P/N 37114
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, blade, 5/32"
Screwdriver, holding
Wrench, hex .050 (Allen)
Digital voltmeter (DVM)
Wire cutters (dikes)
Post clamp, P/N 38236

PROCEDURE 1: DISASSEMBLY

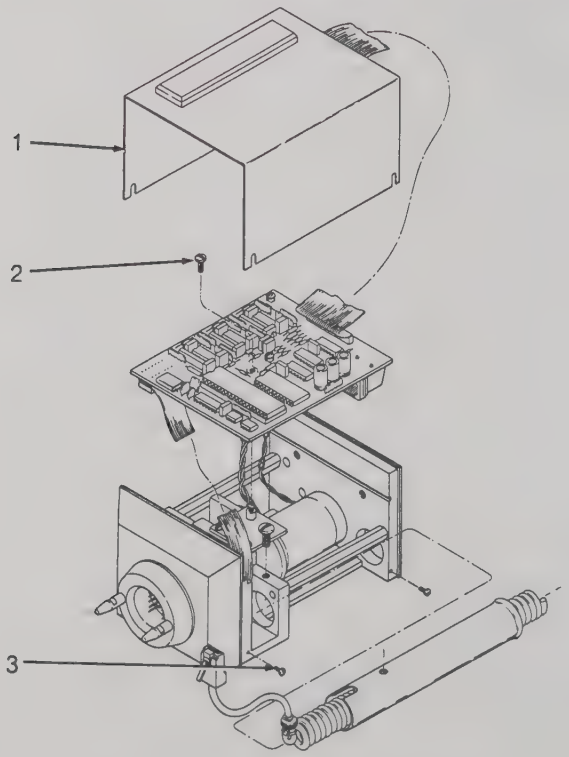
A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Position the arm with the wrist box toward you.

> *Note: This position must not have a rotary value greater than 360 degrees or less than 0 degrees.*

4. Position the arm vertically so that the wrist box is at a convenient working height.
   a. Install a post clamp to temporarily hold the arm housing in this position.
5. Pull the arm to the fully OUT position.
6. Loosen (two turns) the four screws that secure the wrist box cover.
7. Carefully lift the wrist box cover and flip it over onto the arm.

   Its cable will act as a hinge and hold the cover on the arm.



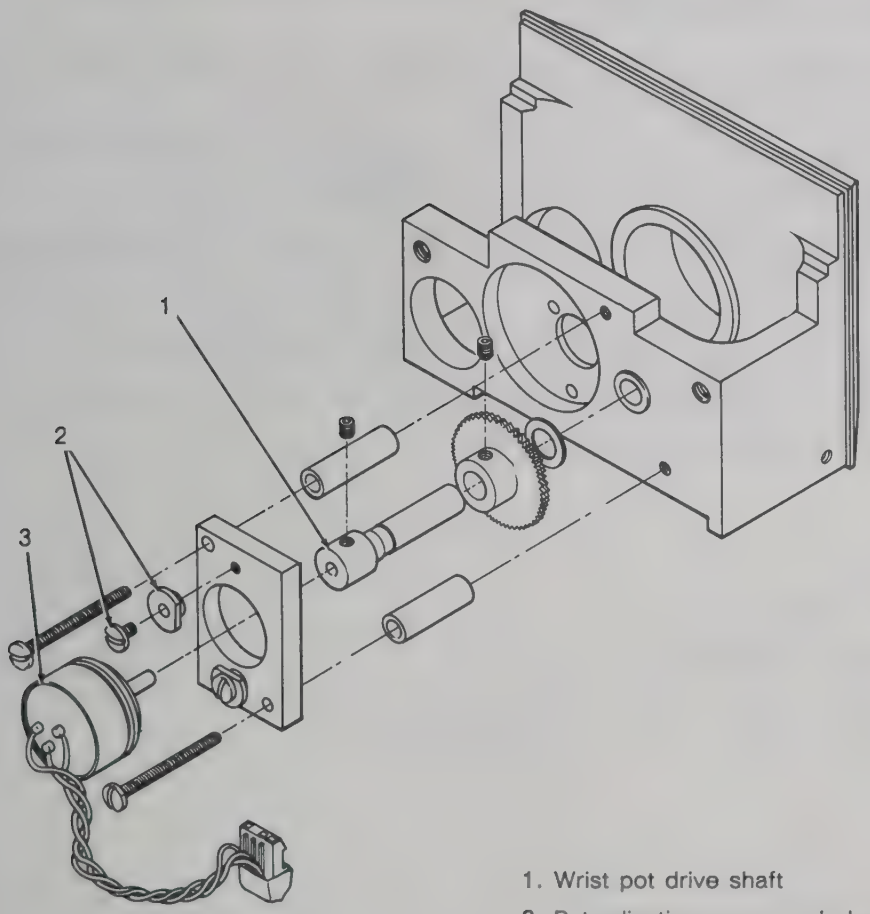
1. Wrist box cover
2. Center screw
3. Cover screw (4)

B. UNFASTEN THE POT

1. Locate the wrist pot and its drive shaft.
2. Loosen the drive shaft set screw NEAREST the pot one turn.

   Turn the Robot's wrist SLIGHTLY if required to access the set screw.

3. Loosen both pot adjusting screws so that the cleats can be turned with the flat FACING THE POT and retighten the screws.

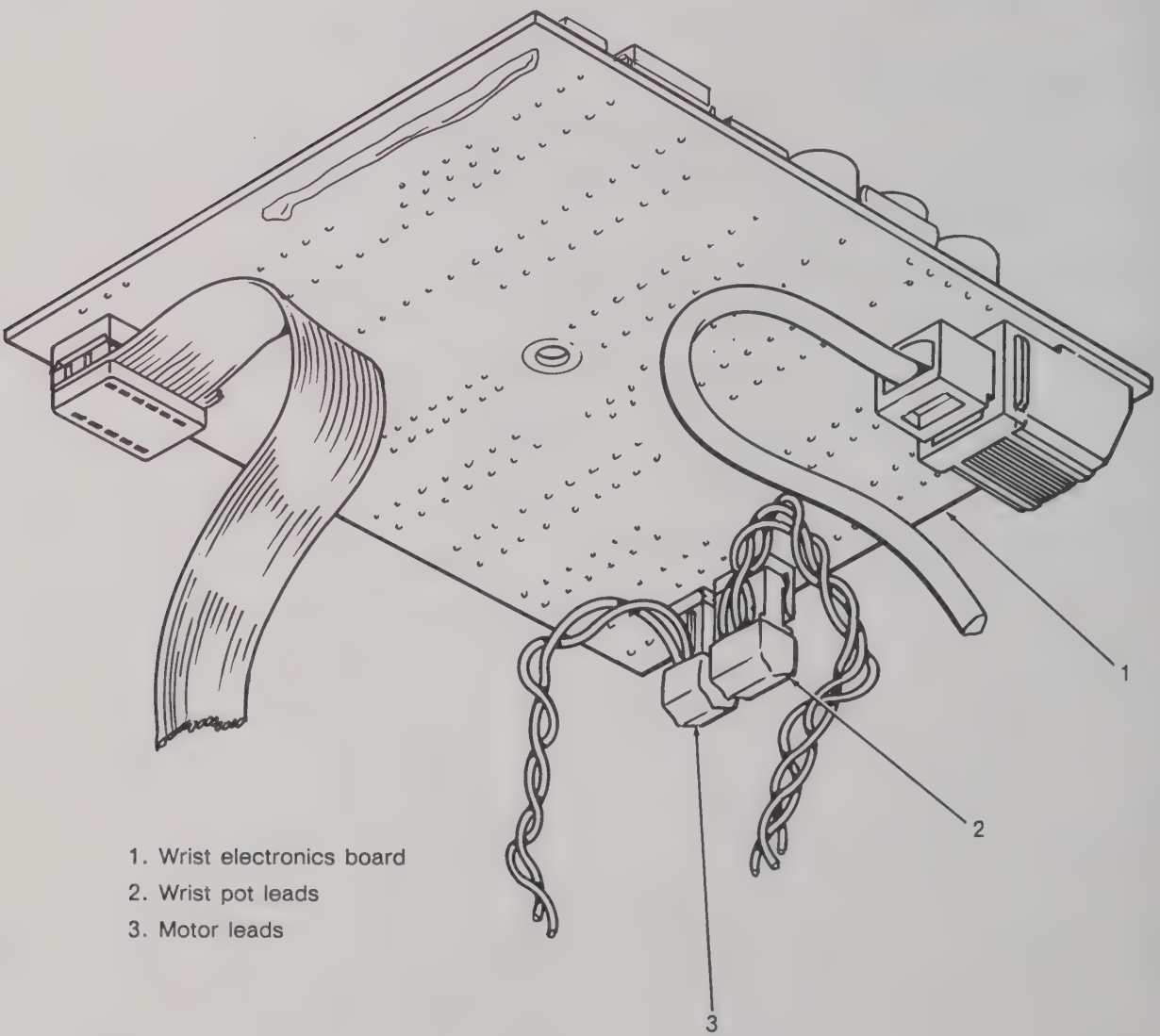


1. Wrist pot drive shaft
2. Pot adjusting screw and cleat (2)
3. Wrist pot

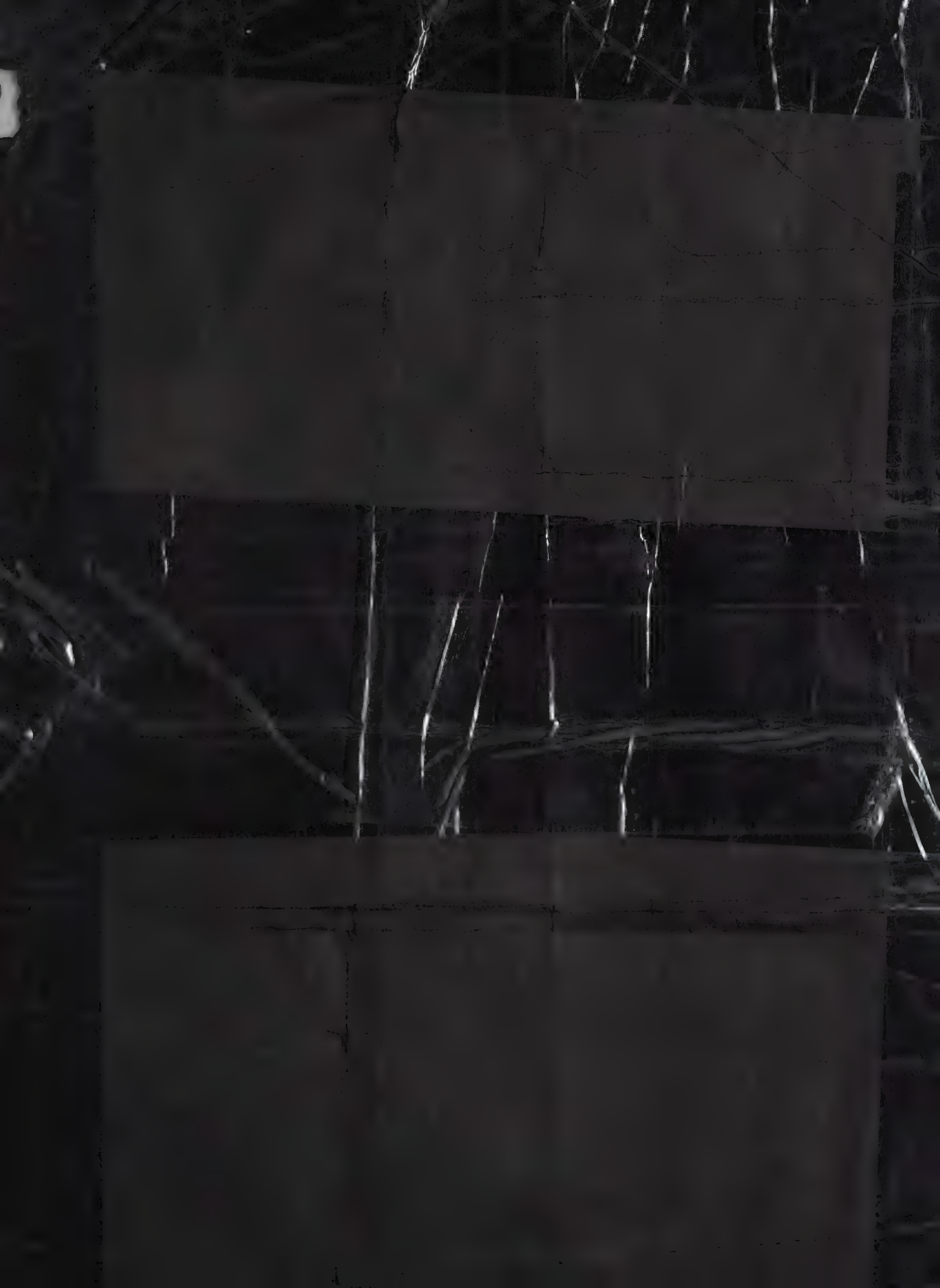
C. REMOVE THE POT

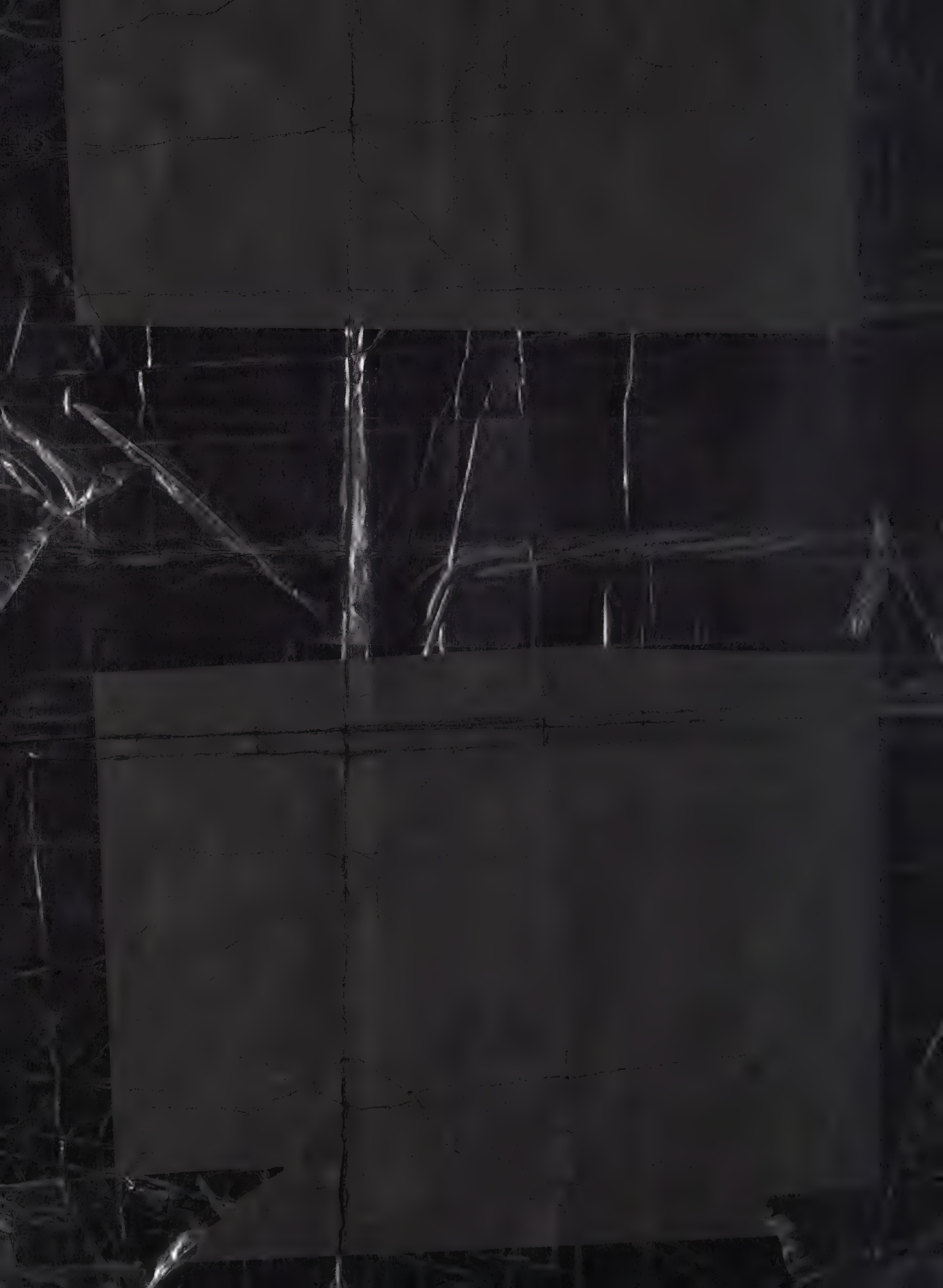
> *Note: It may be necessary to remove the wrist electronics board to facilitate access to the pot and its leads. This is done by removing the center screw.*

1. Draw the pot outward.
2. Unplug the pot from the wrist board.
3. Unplug the motor leads from the wrist board.



1. Wrist electronics board
2. Wrist pot leads
3. Motor leads





PROCEDURE 2: INSTALLATION

A. SET THE NEW POT

1. Connect a digital voltmeter (DVM):
   a. Attach the "–" lead to the pot wiper connection (yellow wire, terminal #2).
   b. Attach the "+" lead to the pot +5V connection (red wire, terminal #3).
2. Set the DVM to: Ohms, 1x setting.
3. Turning the pot shaft, set the pot to a resistance reading of 350 ohms.
4. Disconnect the DVM.

B. FASTEN THE POT

1. Being CAREFUL to avoid turning the pot shaft, slide the pot into position.
2. Loosen both adjusting screws and turn the cleats to engage the flange at the front of the pot body.
3. Tighten both adjusting screws until JUST snug.
4. Tighten the pot drive shaft set screw.
5. Plug the pot into the wrist board.
6. Check that the pot leads are neatly dressed.
7. Plug the wrist motor leads in.
8. Secure the wrist board if removed.

PROCEDURE 3: POSITION ADJUSTMENT

Loosening the adjusting screws and cleats permit the pot body to be turned, changing the Robot's wrist angle.

A. WRIST ZERO ADJUSTMENT

The wrist board may have to be moved slightly to gain access to the screws. If so, use an insulating piece of paper under the board to prevent shorting. Turn OFF Robot power before removing the wrist board screw.

1. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
2. Turn the Robot's power ON. Note that Zymate II Robots also require Controller power to be ON and the wrist angle set to zero degrees.
3. Lay a steel rule across the two wrist coupling pins and carefully measure the distance from each end of the rule to the benchtop.
4. Turn the wrist pot until the two measurements are equal to WITHIN .05 inches per 12 inch rule length.

   It usually takes several tries to properly zero the wrist.
5. Retighten the adjusting screws until JUST snug.
6. Recheck the wrist zero one more time.

B. FINALLY

1. Turn the Robot's power OFF.
2. Reinstall the wrist board.
3. Reinstall the wrist cover and tighten the four screws.

WRIST MOTOR SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the replacement of the wrist motor within the Zymate Robot's wrist box. Because of the amount of disassembly required, replacement of the wrist motor in the field is NOT RECOMMENDED. In most cases, replacement of the entire wrist box assembly is the preferred method. Refer to R39 for wrist box replacement.

This procedure is intended for those isolated cases where wrist box replacement is not practical. This procedure is written for experienced personnel only.

PARTS REQUIRED:

Wrist motor assembly, P/N 37115
Set screw, 10-32 x 1/2, P/N 38846
Cable tie, 4", P/N 36740
Anti-backlash gear and hub assembly, P/N 37321 (OPTIONAL)

TOOLS REQUIRED:

Screwdriver, blade, 1/4" and 5/32
Screwdriver, Phillips, #1
Wrench, hex (Allen), 3/32, 1/8 and .050
Wrench, adjustable
Snap ring pliers
Wire cutters
Loctite 222®

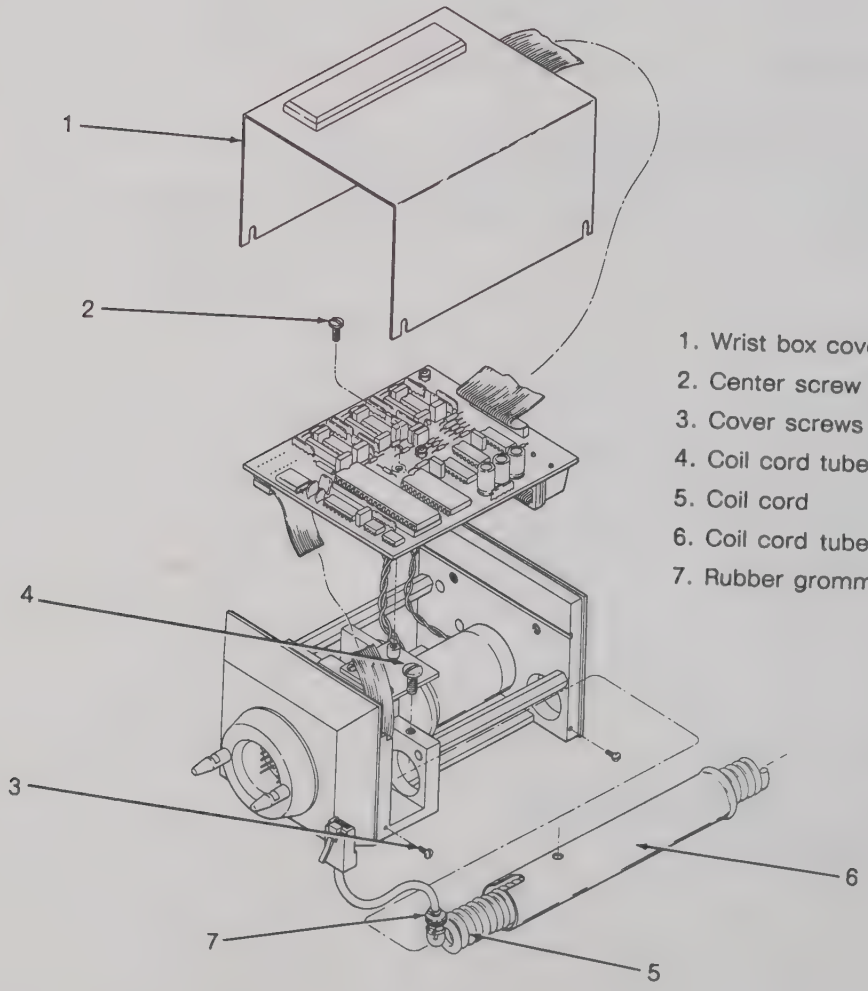
OPTIONAL:

Robot post clamp, P/N 38236
Masking tape

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

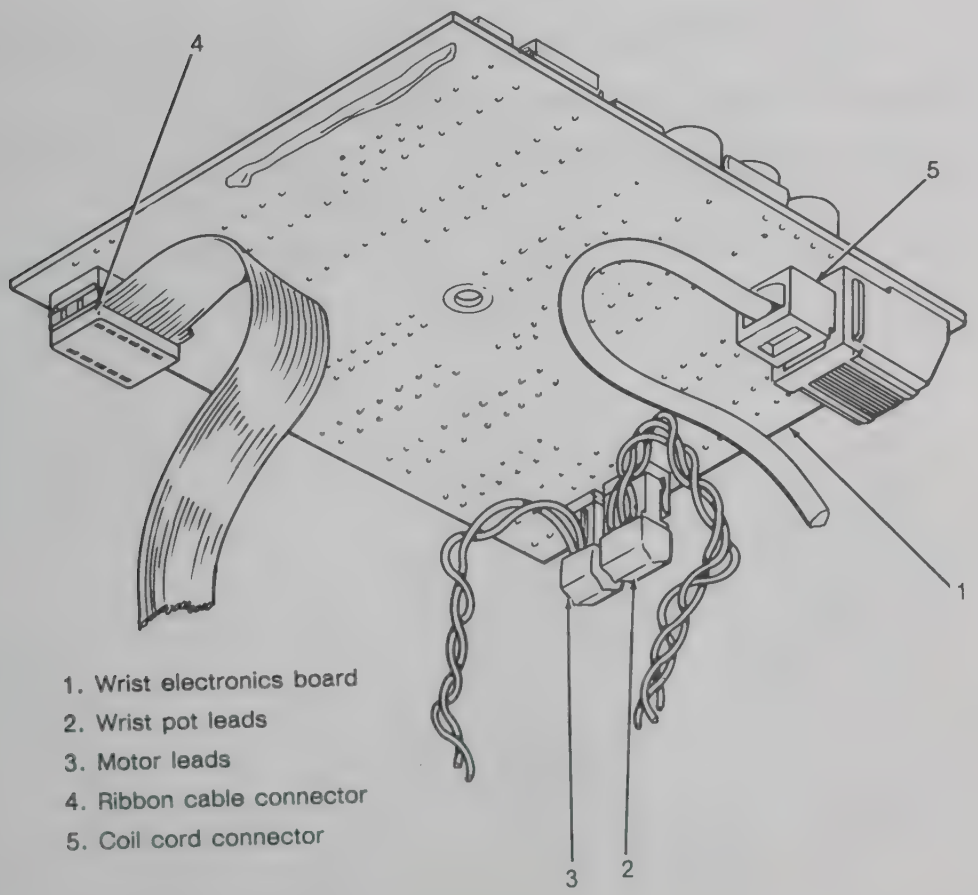
1. From the Robot teaching screen, set the wrist angle to zero.
2. Turn the Controller's power OFF.
3. Turn the Robot's power OFF.
4. Position the arm in a convenient working location over the benchtop. If necessary, install a post clamp to temporarily hold the arm housing at a desirable working height.
5. Loosen the four screws that secure the wrist box cover.
6. Lift the wrist box cover and carefully "hinge" it over onto the arm.



1. Wrist box cover
2. Center screw
3. Cover screws (4)
4. Coil cord tube fastening screw
5. Coil cord
6. Coil cord tube
7. Rubber grommet

B. REMOVE THE BOARD AND WRIST COVER ASSEMBLY

1. Remove the center screw from the wrist electronic board.
2. Carefully lift the board from the wrist box to allow access to the four connectors on the bottom side of the board.
3. Unplug the potentiometer and motor leads.
4. Using a small flatblade screwdriver, pry the ribbon connector from its socket.
5. Using the same screwdriver, push against the clip at the top of the coil cord connector and unplug the cord.
6. Maintaining the ribbon cable connection between the wrist electronics board and the wrist cover board, carefully remove the wrist cover assembly and wrist electronics board and set aside.



1. Wrist electronics board
2. Wrist pot leads
3. Motor leads
4. Ribbon cable connector
5. Coil cord connector

C. DISCONNECT THE COIL CORD

1. Remove the coil cord tube fastening screw.
2. Remove the coil cord tube from the wrist box:
   a. Pull the rubber grommet and cord out of the notch in the tube.
   b. Allow the cord to retract into the tube and slide the tube out of the wrist box.

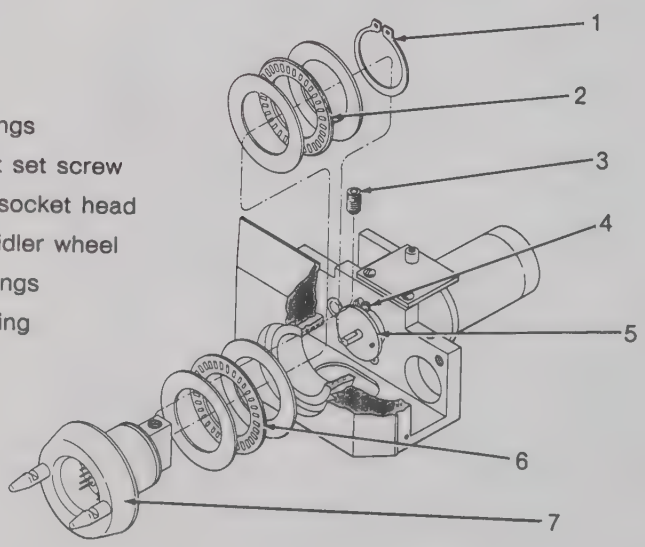
> *Note: Avoid twisting or uncoiling of the cord during handling. GAINING or LOSING turns will change the effective cord length.*

3. Resecure the rubber grommet and coil cord back into the notch in the tube.
4. Tape the coil cord and tube to the arm housing.

D. REMOVE SET SCREW AND WRIST STOP

1. If necessary, manually turn the wrist coupling to the zero position.
2. Move the ribbon cable towards the front of the wrist box to gain access to the wrist stop socket head and the motor shaft set screw.
3. Remove the wrist stop socket head using the 3/32 Allen wrench.
4. Using the 1/8 Allen wrench, remove the motor shaft set screw.

1. Snap ring
2. Inner bearings
3. Motor shaft set screw
4. Wrist stop socket head
5. Wrist stop idler wheel
6. Outer bearings
7. Wrist coupling



E. REMOVE WRIST CABLE

1. Turn the wrist coupling COUNTER-CLOCKWISE to unwind the wrist cable.
2. Unplug the wrist cable connector from the inside of the wrist coupling.

F. REMOVE WRIST COUPLING

1. Using the snap ring pliers, remove the snap ring and slide it towards the end of the wrist coupling.
2. Remove the wrist coupling with its outer bearings from the wrist box.
3. Remove the inner bearings and snap ring from the wrist box.
4. Pull the wrist stop idler wheel from the motor shaft and set aside with the bearings, snap ring and wrist coupling.

G. REMOVE WRIST BOX FRONT

1. Remove the four screws that secure the wrist box front to the rear section of the wrist box.

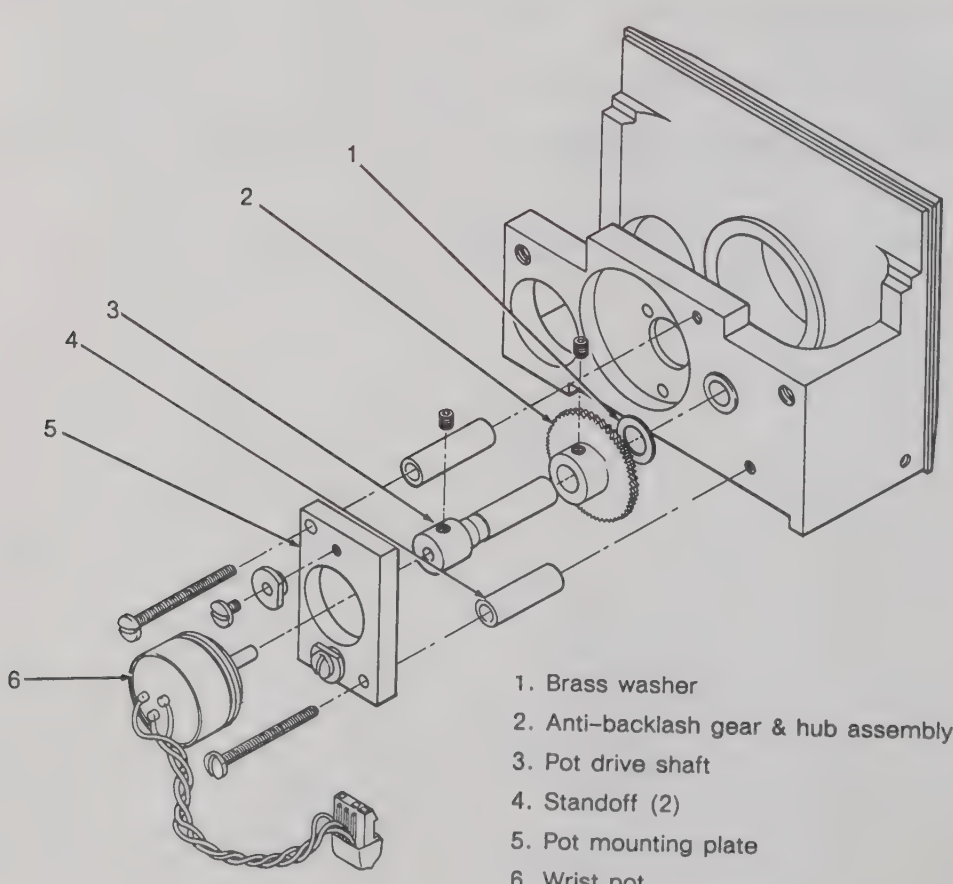
   There are two screws on the bottom-front of the wrist box and two on the wrist box back plate.

2. Remove the front section of the wrist box.

H. REMOVE WRIST POSITION POTENTIOMETER

> *Note: Avoid turning the wrist pot shaft during the following steps. This will insure that the pot maintains a reasonably accurate wrist zero setting when reassembling the wrist.*

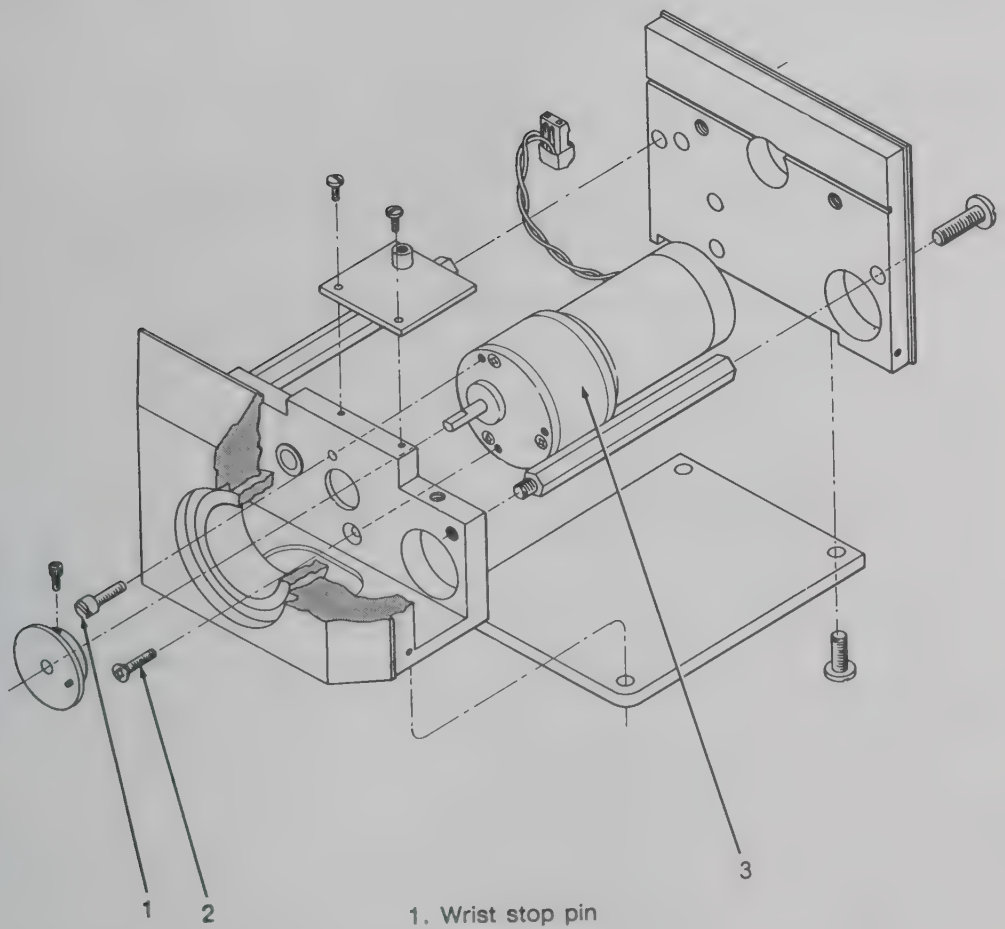
1. Carefully snip the cable tie securing the motor and pot leads together.
2. Loosen the pot drive shaft set screw one turn.
3. Remove the two screws that secure the pot mounting plate.
4. Carefully pull the pot/pot mounting plate assembly, standoffs and screws from the pot drive shaft and set aside.
5. Loosen the gear and hub assembly set screw one turn.
6. Withdraw the pot drive shaft, gear and hub assembly and brass washer from the housing and set aside.



1. Brass washer
2. Anti-backlash gear & hub assembly
3. Pot drive shaft
4. Standoff (2)
5. Pot mounting plate
6. Wrist pot

I. REMOVE WRIST MOTOR

1. Using a flatblade screwdriver, remove the wrist stop pin securing the motor to the wrist box housing.
2. Using a Phillips screwdriver, remove the Phillips head screw securing the motor to the wrist box housing.
3. Slide the motor out of the wrist box.



1. Wrist stop pin
2. Phillips head screw
3. Wrist motor

PROCEDURE 2: INSTALLATION

A. MOUNT NEW WRIST MOTOR

1. Hold the motor with its shaft pointed towards you.
2. Turn the motor body so that the terminals point to your left.
3. Using an adjustable wrench, carefully turn the motor shaft until the shaft flat faces UP.
4. Mount the motor into the wrist box with the wrist stop pin and Phillips head screw previously removed. Use Loctite 222® on both fasteners. Note that the wrist stop pin goes in the upper mounting hole.

B. INSTALL POSITION POTENTIOMETER

If the wrist is not equipped with an anti-backlash gear and hub assembly, it is recommended that one be installed at this time. Refer to R71 for details concerning the installation of the anti-backlash gear.

With the wrist box front facing downward on a flat work surface:

1. Install the brass washer into position over the mounting bearing.
2. Insert the pot drive shaft into the gear and hub assembly and position them so that both set screws are aligned.
3. Insert the drive shaft/gear and hub assembly pair through the washer and into the mounting bearing. Make sure both set screws face towards the top of the wrist box.
4. Insert the tip of the small screwdriver into the teeth of the two anti-backlash gears and move the two gears until their teeth are aligned. Once aligned, center the gears into the teeth of the motor gear, allowing the spring action of the gears to grip the motor gear.
5. Tighten the gear and hub assembly set screw.
6. Reinsert the pot/pot mounting plate assembly using the two standoffs and screws.

> *Note: The hole in the pot mounting plate is not symmetrically located. Make sure that the plate is mounted with the pot offset toward the motor. See the diagram for details.*

7. Check to insure that the anti-backlash gear teeth are still centered within the motor gear.
8. Securely tighten the pot drive shaft set screw.

C. INSTALL WRIST COUPLING

1. Insert the wrist stop idler wheel onto the motor shaft and verify that it rotates freely. Position the wheel so that the screw hole is in the 2:00 o'clock position when viewed from the front of the wrist box.

2. Insert the wrist coupling with outer bearings part-way into the wrist box. Holding the inner bearings and snap ring in position, fully insert the wrist coupling through the bearings and snap ring.

3. Using the snap ring pliers, secure the snap ring in place (concave side toward motor) with the opening of the snap ring in the 3:00 o'clock position when viewed from the front of the wrist box. Make sure that it is fully seated all around.

D. INSTALL MOTOR SHAFT SET SCREW

1. Apply Loctite 222® to the motor shaft set screw.

2. With the wrist coupling in the zero position, insert the set screw and tighten securely.

E. INSTALL WRIST CABLE

Facing the front of the wrist box:

1. Push the wrist cable connectors fully into the back of the wrist coupling, with the white wire located top-right and the red wire located top-left.

2. Extend the cable horizontally to the right of the wrist box and orient the connector so that the connector pins face downward. (This correctly aligns the cable for the next step).

3. Using the motor shaft set screw as a reference, turn the wrist coupling SLOWLY CLOCKWISE three turns. When pulled to the left, approximately 4-5 inches of wrist cable should extend beyond the wrist box.

4. With the screw hole in the wrist stop idler wheel located just right of the wrist stop pin, install the wrist stop socket head using Loctite 222®.

F. ASSEMBLE WRIST BOX FRONT

1. Attach the wrist box front to the rear section of the wrist box using the four screws previously removed. Make sure to tighten the two screws on the back plate BEFORE tightening the the screws on the bottom.

G. CONNECT COIL CORD

1. Pull the coil cord and grommet out of the notch in the coil cord tube and feed the cord into the wrist box.
2. Slide the coil cord tube into position within the wrist box and resecure the cord and grommet into the notch.
3. After aligning the tube, secure the tube in place with the coil cord tube screw.

H. REINSTALL WRIST BOARD AND WRIST COVER ASSEMBLY

1. Plug the four connectors into the wrist electronics board.
2. Secure the board to the wrist box with the center screw.

PROCEDURE 3: POSITION ADJUSTMENT

A. WRIST ZERO ADJUSTMENT

Move the wrist board slightly to gain access to the screws. Use an insulating piece of paper under the board to prevent shorting. Turn OFF Robot power before removing the wrist board screw.

1. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
2. Turn the Robot's power ON.

> *Note: Zymate II Robots also require that Controller power be ON and the wrist be set to the zero degree position.*

3. Lay a steel rule across the two wrist coupling pins and carefully measure the distance from each end of the rule to the benchtop.
4. Turn the wrist pot until the two measurements are equal to within .05 inches per 12 inch rule length.
5. Retighten the adjusting screws until JUST snug.
6. Recheck the wrist zero.

B. FINALLY

1. Turn the Robot's power OFF.
2. Reinstall the wrist cover and tighten the four screws.
3. Turn the Robot's power ON.
4. Turn the Controller's power ON.

WRIST REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure describes the steps necessary to replace a wrist assembly in the Zymate Robot.

PARTS REQUIRED:

Wrist assembly: P/N 36788 (Zymate I)
P/N 39602 (Zymate II)

TOOLS REQUIRED:

Screwdriver, flatblade, 1/4"
Screwdriver, precision, 1.2mm, 4" long
Wrench, open end, 5/16"
Steel rule, 12" or longer
Tape, masking

OPTIONAL:

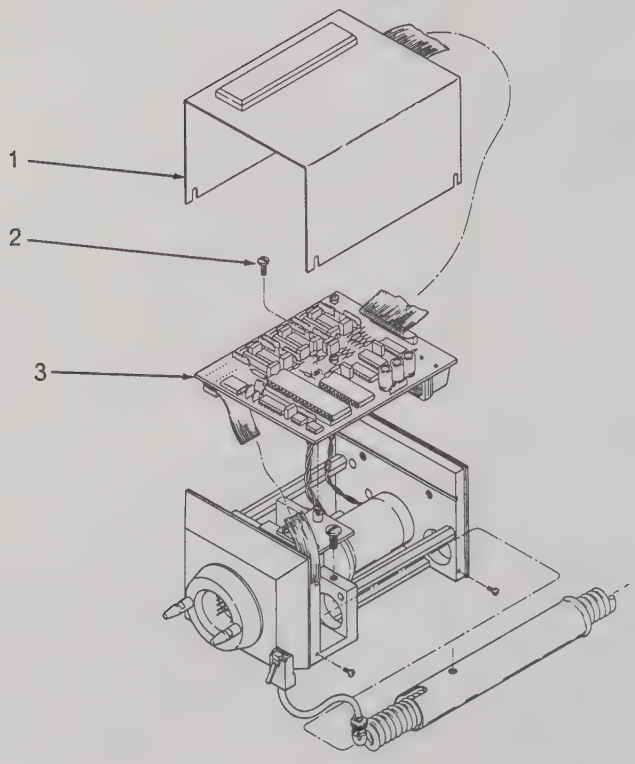
Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

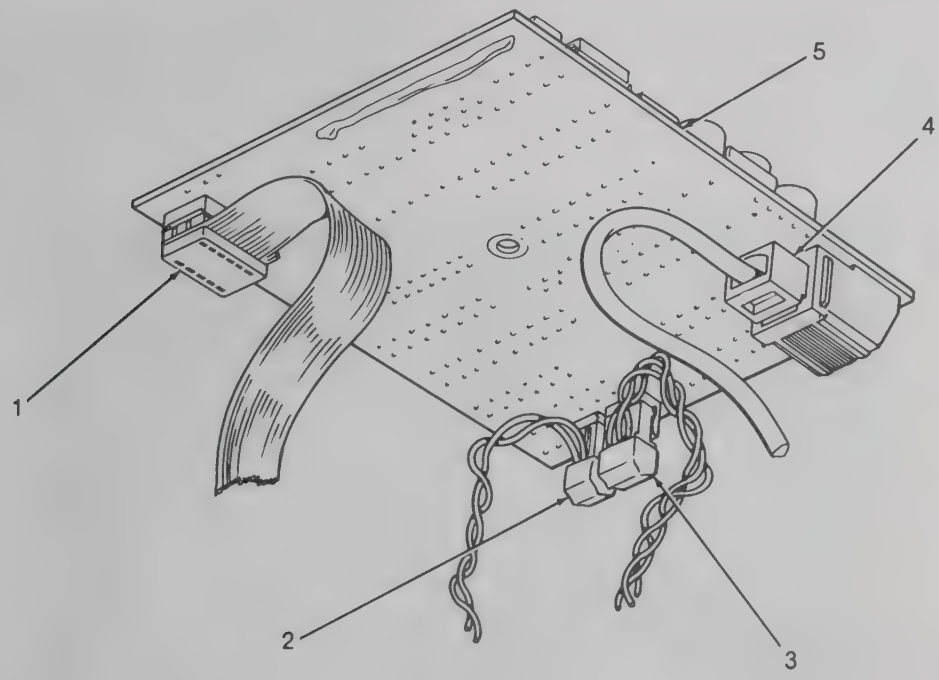
1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and unplug the power cord.
3. Position the arm in a convenient working location over the benchtop. If necessary, install a post clamp to temporarily hold the arm housing at a desirable working height.
4. Loosen the four screws that secure the wrist box cover.
5. Lift the wrist cover and carefully "hinge" it over onto the arm.



1. Wrist box cover
2. Center screw
3. Wrist pcb

B. REMOVE THE WRIST BOARD AND WRIST COVER ASSEMBLY

1. Remove the center screw from the wrist electronics board.
2. Carefully lift the board from the wrist box to allow access to the four connectors on the bottom side of the board.
3. Unplug the potentiometer and motor leads.
4. Using a small flatblade screwdriver, carefully pry the multi-colored ribbon cable connector from its socket.
5. Using the same screwdriver, push against the clip at the top of the coil cord connector and unplug the cord.
6. Maintaining the ribbon cable connection between the wrist electronics board and the wrist cover board, carefully remove the assembly and temporarily set aside.



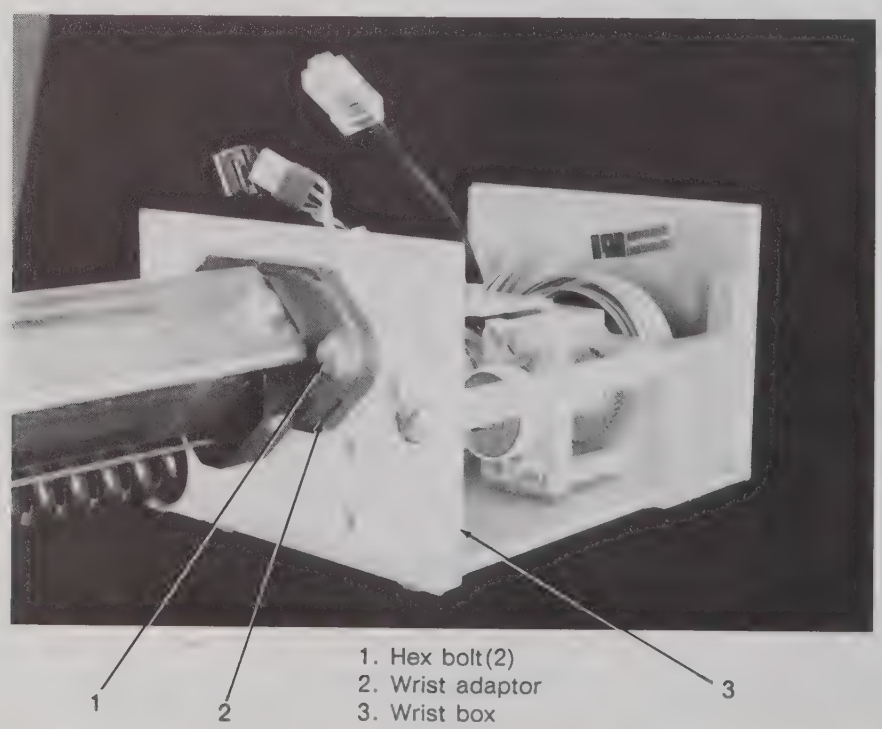
1. Ribbon cable connector
2. Wrist motor connector
3. Wrist pot connector
4. Communication cable
5. Wrist pcb

C. REMOVE THE WRIST

1. Loosen the coil cord tube fastening screw.
2. Remove the coil cord tube from the wrist box:
   a. Pull the rubber grommet and cord out of the notch in the tube.
   b. Allow the cord to retract into the tube and slide the tube out of the wrist box.

> *Note: Avoid twisting or uncoiling of the cord during handling. GAINING or LOSING turns will change the effective cord length.*

3. Resecure the rubber grommet and coil cord back into the notch in the tube.
4. Tape the coil cord and tube to the arm housing.
5. Using the 5/16 wrench, remove the two hex bolts securing the wrist adaptor to the rear of the wrist box. Do NOT loosen or remove the bolts that attach the Robot arm to the wrist adaptor. It is necessary to support the wrist in place while removing the last bolt.



1. Hex bolt(2)
2. Wrist adaptor
3. Wrist box

6. After removing the wrist, reattach the connectors to the wrist electronics board, secure the board in place with the center screw and replace the wrist cover assembly.

PROCEDURE 2: INSTALLATION

A. INSTALLING THE NEW WRIST

1. Before installing the new wrist, "unhinge" the wrist cover and remove the wrist electronics board/wrist cover assembly as in procedure 1, section B.
2. With the board and wrist cover assembly removed, attach the new wrist to the wrist adaptor using the two hex bolts.

B. CONNECT COIL CORD

1. After untaping the coil cord tube assembly from the arm housing, pull the coil cord and grommet out of the notch in the coil cord tube and feed the cord into the wrist.
2. Slide the coil cord and tube into position within the wrist box and anchor the cord and grommet in the notch.
3. After aligning the tube, secure the tube in place by tightening the coil cord tube screw.

C. REINSTALL WRIST BOARD AND WRIST COVER ASSEMBLY

1. Plug the four connectors into the wrist electronics board.
2. Secure the board to the wrist box with the center screw.

PROCEDURE 3: POSITION ADJUSTMENT

A. WRIST ZERO ADJUSTMENT

Move the wrist board slightly to gain access to the screws. Use an insulating piece of paper under the board to prevent shorting. Turn OFF Robot power before removing the wrist board screw.

1. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
2. Plug in the power cord and turn the Robot's power ON.

> *Note: For Zymate II Robots, also turn the Controller ON and set the wrist angle to zero.*

3. Lay a steel rule across the two wrist coupling pins and carefully measure the distance from each end of the rule to the benchtop.
4. Turn the wrist pot until the two measurements are equal to within .05 inches per 12 inch rule length.
5. Retighten the adjusting screws JUST snug.
6. Recheck the wrist zero.

B. FINALLY

1. Turn the Robot's power OFF.
2. Reinstall the wrist cover and tighten the four screws.
3. Turn the Robot's power ON.
4. Turn the Controller's power ON.

REACH BEARING AND ARM REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the reach bearings and/or the arm in the Zymate Robot.

PARTS REQUIRED (as needed):

Arm assembly, P/N 36073
(4) Reach bearing assemblies, P/N 36033
Epoxy Patch Kit, P/N 37452
(3) Screws 8/32 x 3/8, Nylok, P/N 37362

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8", 3/16"
Screwdriver, Phillips #1
Driver, ball-end, 9/64
Wrench, box-end, 5/16
Wrench, Allen, .050
Square, 12"
Masking tape

OPTIONAL:

Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

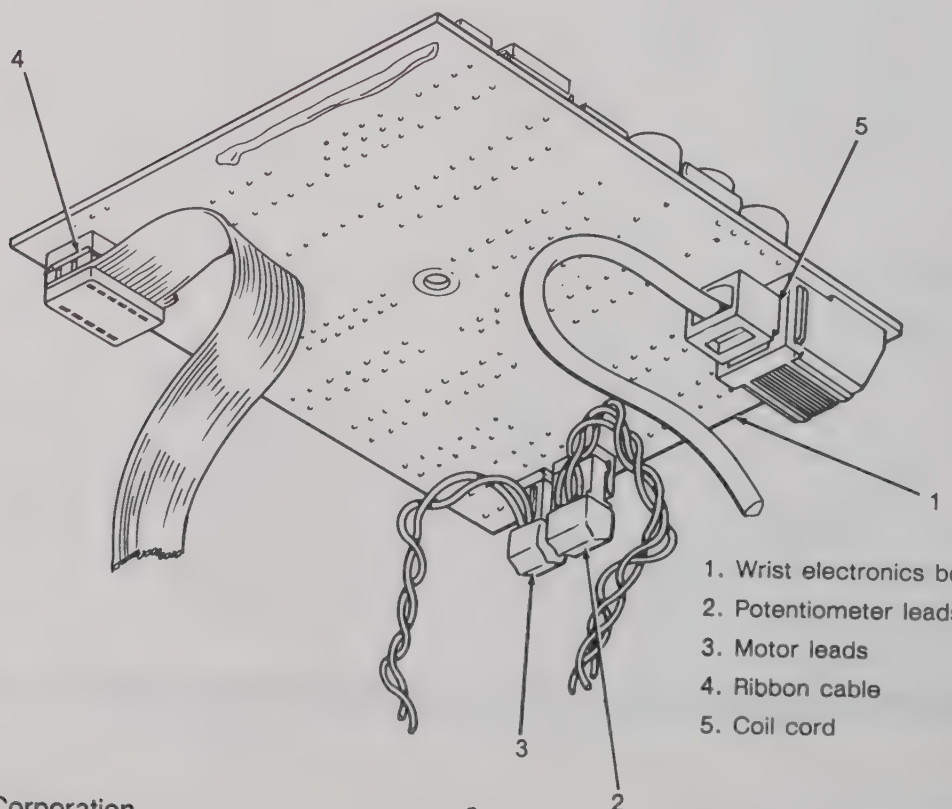
PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and disconnect the power cord.
3. Move the arm vertically to mid-height. Install a post clamp (or other means of support) to hold the arm housing in position.
4. Pull the arm out half way.

B. REMOVE THE COIL CORD FROM THE WRIST

1. Loosen (two turns) the four screws that secure the wrist cover.
2. Lift the wrist cover and carefully "hinge" it over onto the arm.
3. Remove the center screw from the wrist electronics board.
4. Carefully lift the board from the wrist box to allow access to the four connectors on the bottom side of the board.
5. Unplug the potentiometer and motor leads.

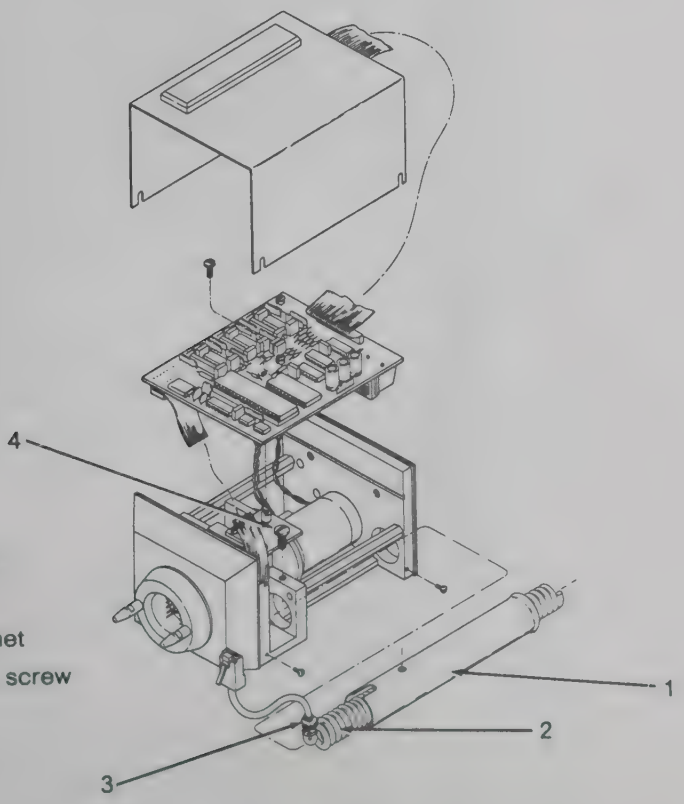


1. Wrist electronics board
2. Potentiometer leads
3. Motor leads
4. Ribbon cable
5. Coil cord

6. Using a small flatblade screwdriver, carefully pry the multi-colored ribbon cable connector from its socket.
7. Using the same screwdriver, push against the clip at the top of the coil cord connector and unplug the cord.
8. Maintaining the ribbon cable connection between the wrist electronics board and the wrist cover board, carefully remove the assembly and set aside.
9. Loosen the coil cord tube fastening screw.
10. Remove the coil cord tube from the wrist box:
    a. Pull the rubber grommet and coil cord out of the notch in the tube.
    b. Allow the cord to retract into the tube and slide the tube out of the wrist box.

> *Note: Avoid twisting or uncoiling of the cord during handling. GAINING or LOSING turns will change the effective cord length.*

11. Resecure the rubber grommet and coil cord back into the notch in the tube.
12. Temporarily tape the coil cord and tube to the arm housing.



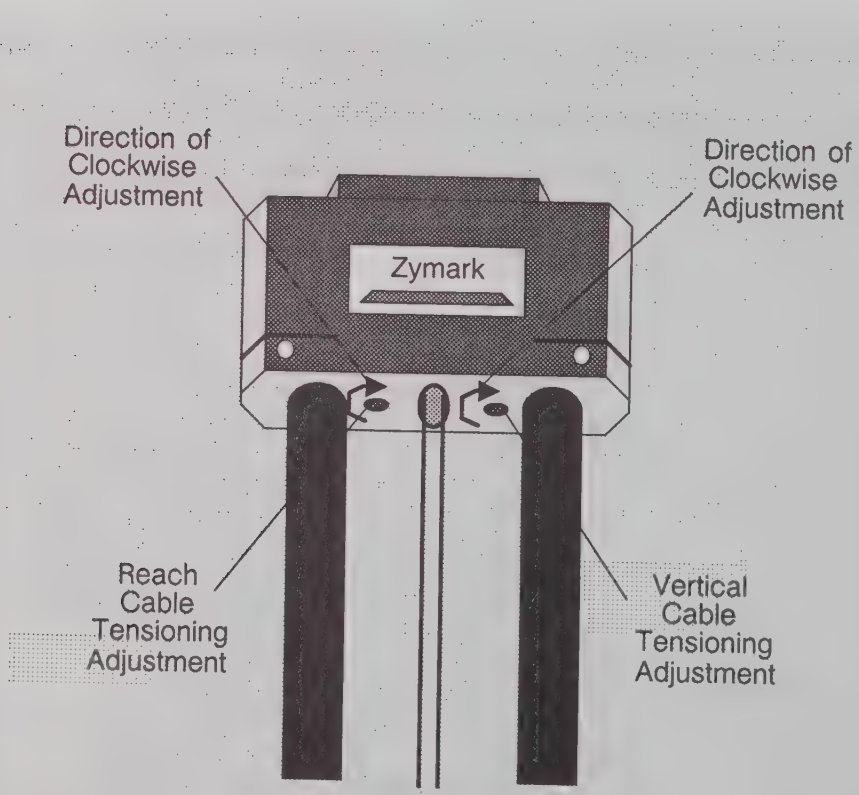
1. Coil cord tube
2. Coil cord
3. Rubber grommet
4. Coil cord tube screw

C. RELAX CABLE TENSION

1. Using the 9/64 ball-end driver, turn the reach drive cable tensioning adjustment fully CLOCKWISE.

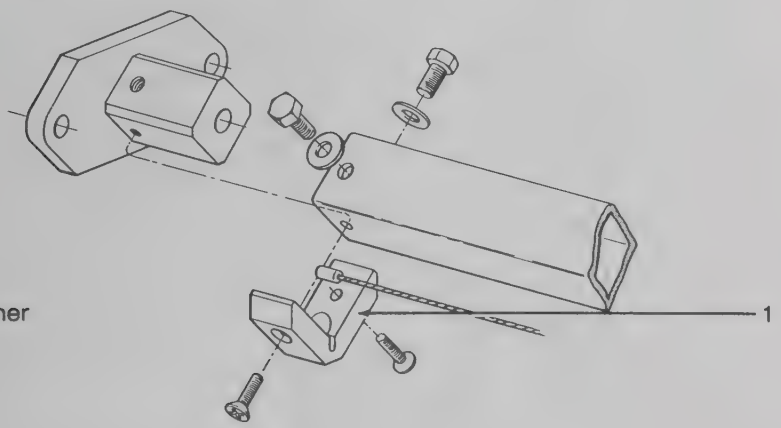
   See the diagram below for the adjustment location.

2. Remove the cover on the top of the column cap assembly.
3. Turn the compression screw next to the reach cable pulley fully CLOCKWISE.
4. Securely tape the reach cable to the pulley.
5. Run a piece of tape across the cable wraps on the reach drum.

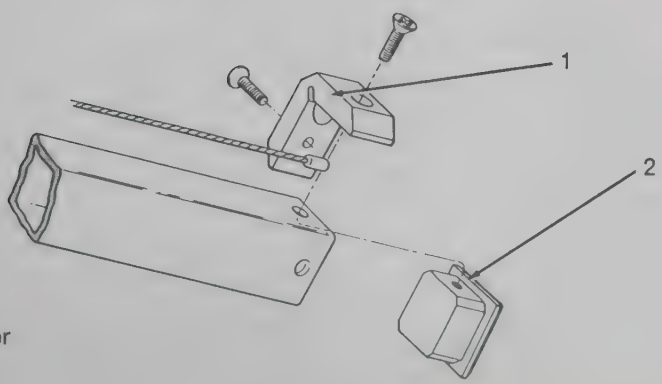


D. DISCONNECT CABLE ENDS

1. Secure both reach cables to the arm by placing a piece of tape across each cable and onto the arm (about mid-way between the arm housing and the arm ends). This will insure that the cables do not come detached from the pulleys within the arm housing.
2. Using a Phillips screwdiver, remove the black V-shaped cable retainer at each end of the arm.
3. Remove the black plug at the rear of the arm.
4. Maintaining outward tension on the cable-end extending toward the rear of the arm, remove the tape from around the cable and arm.
5. Continue to place an outward and upward tension on the cable and tape the cable to the arm housing directly above the point where it exits the housing.
6. Similarly, maintain tension on the cable-end that extends toward the wrist and remove the tape securing the cable to the arm.
7. Placing an outward and downward tension on the cable, tape it in place to the arm housing directly below the point where it exits the housing.



1. Cable retainer

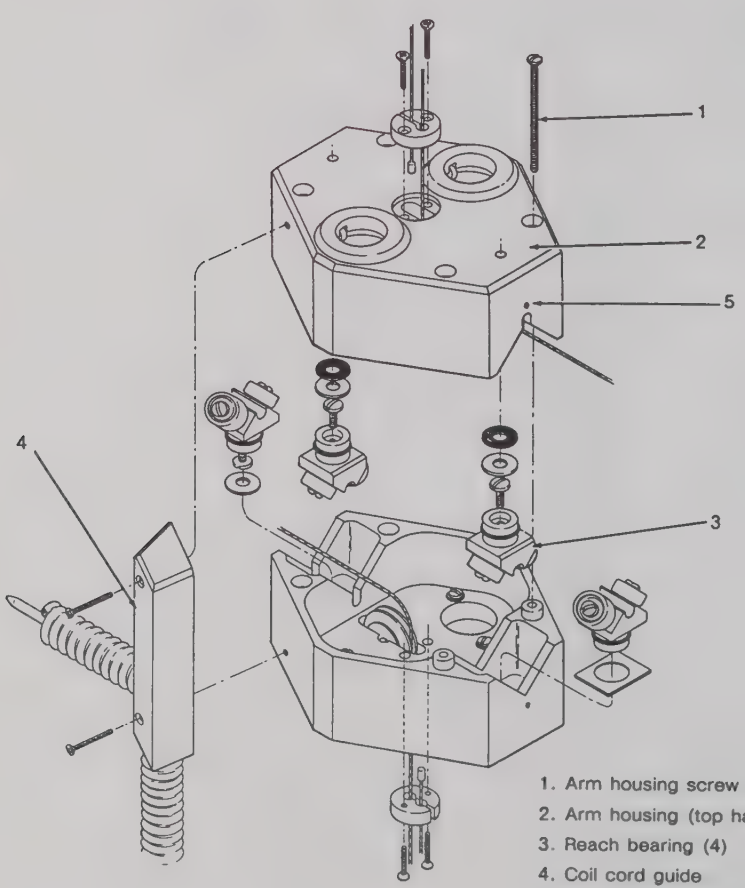


1. Cable retainer
2. Plug

E. REMOVE THE ARM AND BEARINGS

1. Detach the coil cord guide from the arm housing by first removing the two Phillips head screws.
2. Remove the taped coil cord and set aside the entire coil cord/coil cord guide assembly, being careful not to twist or uncoil the cord.
3. Locate the four set screws that secure the reach bearings.* Two are located on the arm housing just above and below the point where the arm exits from the front of the housing. The other two are located exactly 180° opposite, at the point where the arm exits the rear of the housing.

   ** Robots built prior to 6/88 may not contain the securing set screws.*
4. Using the Allen wrench, loosen (approximately 2 turns) the four set screws.
5. Remove the four arm housing screws.
6. Using either end of the arm as a lever, push upward to separate the two arm housing halves.



1. Arm housing screw (4)
2. Arm housing (top half)
3. Reach bearing (4)
4. Coil cord guide
5. Reach bearing set screw (4)

5. Slide the arm out of the housing.

6. Remove the two upper reach bearings by pushing the bearings out by inserting a narrow screwdriver into the reach bearing adjustment holes and firmly pushing inward. Remove all washers and bearings, noting the location of all parts.

7. Remove the lower front reach bearing in the same manner, again noting the location of all parts removed.

> *Note: Newer Zymate II Robots have an adjustment screw inserted into the lower front bearing. Do NOT make any adjustment to this screw. The overall height of the bearing/screw combination determines Robot leveling and is set at the factory. This height will be duplicated using one of the new bearings and screws in PROCEDURE 2, section A, steps 4 & 5. Set this bearing aside for later reference.*

8. Remove the lower rear reach bearing. If applicable, remove any shim(s) and note their location and order.

F. REMOVE THE WRIST FROM THE ARM

> *Note: This section is necessary ONLY for those Robots whose arms have deep scoring, resulting in flaking of metal fragments even after arm oiling. If there is any doubt as to whether your Robot's arm needs replacement due to the above condition, consult Zymark Service.*

1. Using the 5/16 wrench, remove the two hex bolts securing the wrist adaptor to the wrist box.

2. Remove the wrist and set aside.

3. Again using the 5/16 wrench, remove the two bolts and washers securing the wrist adaptor to the arm. Slide the adaptor from the arm. In some cases wrist adaptors are epoxied to the arm. If so, it is necessary to force the adaptor out by inserting a long steel rod (or other, similar device) through the arm and tapping against the back of the adaptor until the epoxy adhesions break.

PROCEDURE 2: INSTALLATION

A. REPLACE THE BEARINGS

1. Install Nylok screws into two of the new bearings. Turn the screws until they are fully inserted into the bearings.
2. Insert the bearings and any washers previously removed into the upper half of the arm housing. The bearings should audibly snap into place.

> *Note: The following two steps apply ONLY to Robots with an adjustment screw in the lower front reach bearing. If your Robot does not have an adjustment screw in this position, proceed to step 5.*

3. Measure the old, lower front bearing with the attached screw using one of the following methods:
   a. Using a caliper, measure from the top of the bearings to the end of the screw head.

   OR

   b. Count the number of visible threads on the Nylok screw.
4. Using the measurement method chosen in step 3, duplicate the dimension using a new bearing and screw.
5. Insert the lower front bearing in place using any washer(s) previously removed.
6. Insert the lower rear bearing in place using any shim(s) previously removed.
7. Replace the four arm housing screws and alternately tighten each one.

B. INSERT THE ARM

1. Carefully reinsert the arm back into the arm housing. Make sure the arm is inserted with the wrist nearest the side of the arm housing that holds the coil cord support. If the arm and wrist are separated, check that the holes for attaching the wrist adaptor to the arm face upward upon insertion.

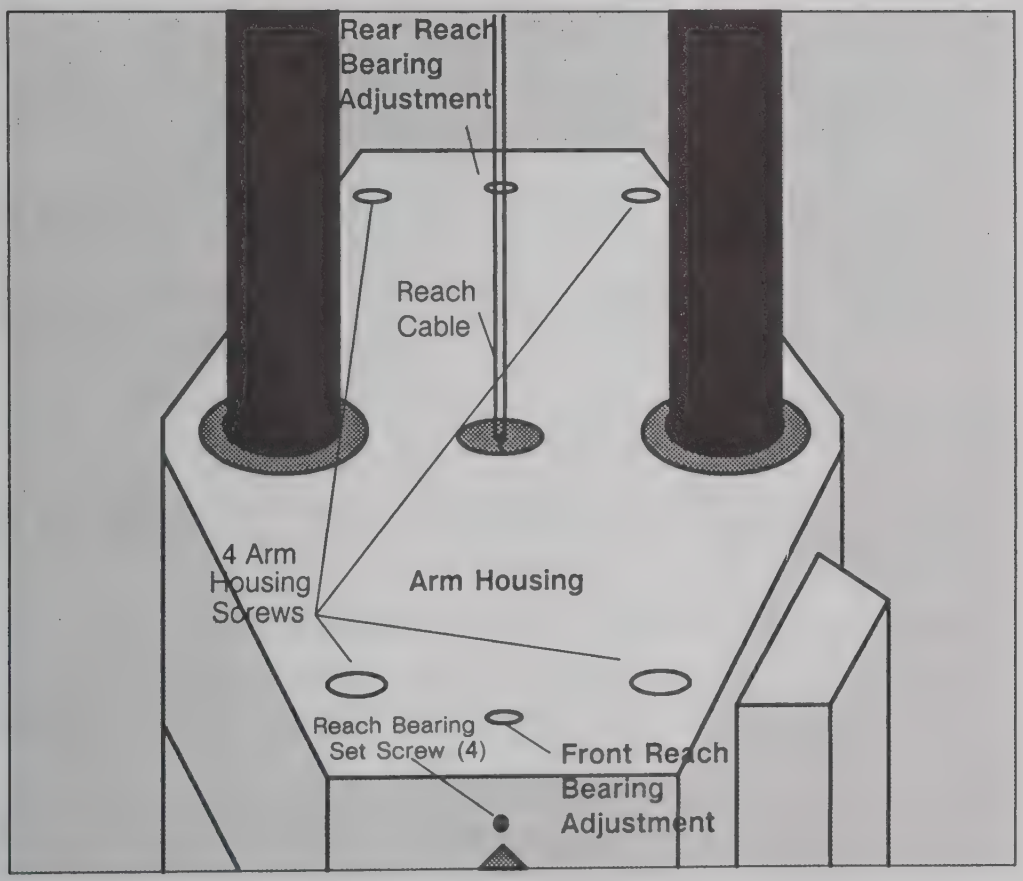
C. ADJUST THE REACH BEARINGS

1. Locate the two small holes on the top of the arm housing for the reach bearing adjustment.
2. Using a small screwdriver, turn the front and rear adjustment screws COUNTER-CLOCKWISE until both are tight.

3. Turn each screw CLOCKWISE 1/8 turn.

> *Note: Follow section D ONLY if your Robot requires a new arm. Otherwise, proceed to section E.*

4. Finally, retighten the four securing set screws until snug.



D. ATTACH THE WRIST TO THE ARM

> *Note: Read the following steps carefully before proceeding! There is more than enough time (before the epoxy sets) to accomplish the installation and the adjustment that follows, providing that the steps are clearly understood and all required tools and materials are ready. If unfamiliar with this procedure, PRACTICE sections D – F WITHOUT the epoxy.*

1. Wipe the inside of the arm tube with a Kimwipe or clean rag to remove any oil or dirt.
2. Mix the epoxy as instructed on the package.
3. Generously apply epoxy to all four surfaces inside the arm tube, JUST BEYOND the holes on the wrist side of the arm. Try to avoid getting epoxy between the holes and the end of the arm tube.
4. Insert the wrist adaptor into the arm tube, fastening with the two mounting bolts and washers. Tighten until JUST snug.
5. Attach the wrist to the adaptor with the two bolts previously removed. Tighten securely.

E. ATTACH THE CABLES TO THE ARM

1. Pull the wrist end of the arm outward until the cable that is taped to the upper section of the arm housing can extend beyond the end of the arm (with the tape still in place).
2. Insert the black plug into the rear of the arm (threaded holes up).
3. With the tape still in place, capture the ferrule in the V-shaped cable retainer and secure the retainer, cable and black plug in place with the two Phillips screws previously removed.
4. Pull outward on the rear of the arm with just enough force to allow the cable to break the tape on the housing. Maintaining enough outward pull to keep the cable taut, apply pieces of tape across the arm housing and onto the arm. Do this on both the front and rear sections of the arm to insure that the arm does not move within the housing.
5. Pull the end of the lower cable away from the front of the arm housing until the cable breaks the tape on the housing. Maintain slight outward tension on the cable.
6. Capture the ferrule in the V-shaped cable retainer and secure it in place on the wrist end of the arm.

7. Loosen the compression screw in the column cap assembly until the top of the screw is even with the top of the column cap body.
8. Remove the tape from the pulley, reach drum and arm housing.
9. Remove the arm housing support and let the housing settle to the bottom limit of its travel.

> *Note: Follow section F ONLY if your Robot requires a new arm. Otherwise, go to PROCEDURE 3.*

F. SQUARE THE WRIST BOX

1. Use a square to check that the face of the wrist coupling is square to the benchtop:
   a. Use a piece of paper or an .002" feeler gauge between the square and the UPPER and LOWER surfaces of the wrist coupling.
   b. The gap should be less than the paper thickness or (.002").
2. If necessary, adjust the wrist squareness by slightly loosening the two bolts that secure the wrist adaptor to the arm (see section D, step 4) and tilting the wrist either forward or backward.
3. Securely tighten the two bolts and recheck the wrist coupling squareness.

PROCEDURE 3: ADJUSTMENTS

A. TENSION THE CABLES

1. Turn the reach drive cable tensioning adjustment (located on the underside of the column cap assembly) COUNTER-CLOCKWISE until a slight resistance is felt. This resistance is the first contact between the adjusting screw and the cable-tensioning device within the column cap assembly.
2. Continue to turn the adjustment COUNTER-CLOCKWISE one more turn.
3. Reinstall the cover on the column cap assembly.

B. CHECK REACH BEARING ADJUSTMENTS

1. With the Controller and Robot power OFF, manually extend the arm through its full reach.
2. Feel for any binding while moving the arm.
3. Standing in front of the wrist box, check for any bearing sloppiness by rocking the wrist side to side.
4. If binding or sloppiness is detected, readjust the bearings according to PROCEDURE 2, section C and recheck the adjustment.

PROCEDURE 4: REASSEMBLE THE ROBOT

A. REPLACE THE COIL CORD

1. Reattach the coil cord support to the arm housing with the Phillips head screws previously used.
2. Pull the coil cord and grommet out of the notch in the coil cord tube and feed the cord into the wrist.
3. Slide the coil cord and tube into position within the wrist box and anchor the cord and grommet in the notch.
4. After aligning the tube, secure it in place by tightening the coil cord tube screw.

B. REINSTALL WRIST BOARD AND WRIST COVER ASSEMBLY

1. Plug the four connectors into the wrist electronics board.
2. Secure the board to the wrist box with the center screw.

C. SET THE REACH ZERO

1. Refer to R33, PROCEDURE 3 to reset the reach zero for the Robot.

> *Note: This procedure is critical to optimizing Robot performance.*

REACH MOTOR SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the DC servo motor which drives the reach axis.

PARTS REQUIRED:

Reach motor, P/N 36376
Set screw, 10-32 x 1/2, P/N 38846
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, blade, 3/16
Screwdriver, holding
Driver, ball-end hex, 9/64
Wrench, hex (Allen) 3/32
Wrench, adjustable
Wire cutters (dikes)
Loctite 222®

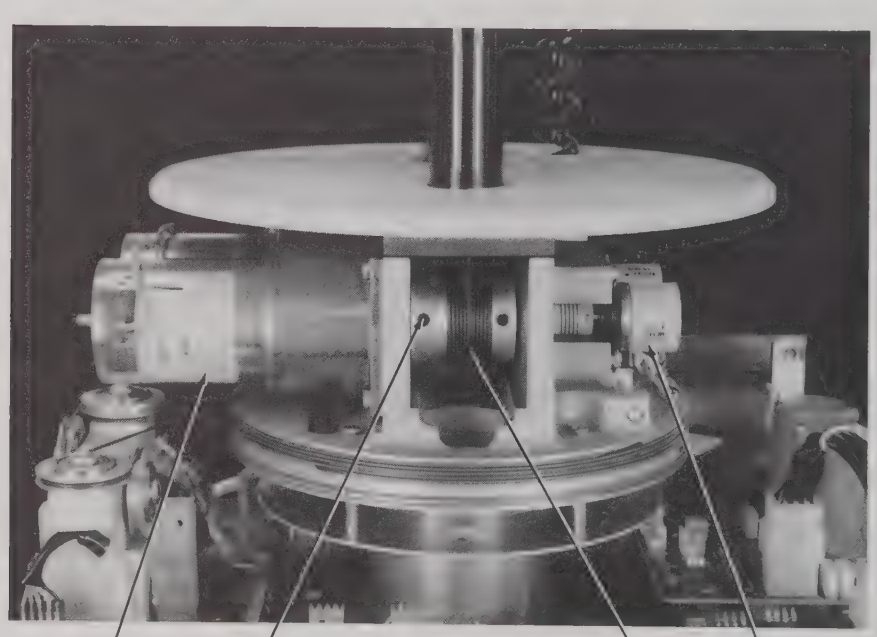
OPTIONAL:

Robot post clamp, P/N 38236

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and disconnect the power cord.
3. Remove both skirts.
4. Turn the arm so the turntable interconnection board faces AWAY from you.
5. Install a post clamp (or other means of support) to support the arm at a convenient height.
6. Locate the drive drum on the end of the reach motor shaft.
   - *The reach motor is on the opposite side from the turntable interconnection board.*
7. Move the arm IN or OUT until the set screws in the drum are accessible.

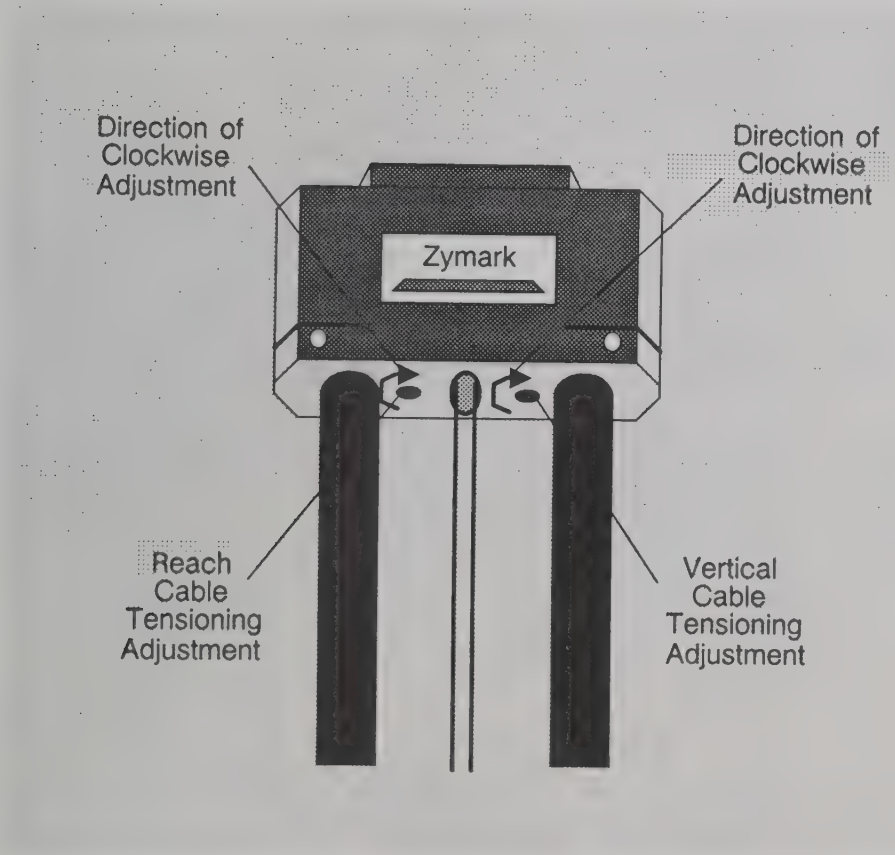


1. Reach motor
2. Set screw(2)
3. Reach drum
4. Reach potentiometer

B. RELAX CABLE TENSION

1. Using a 9/64 ball-end hex driver, turn the reach drive cable tensioning adjustment CLOCKWISE (as viewed from the end of the hex driver) two turns.

    - *This adjustment is made through a small hole in the BOTTOM SIDE of the column cap assembly at the top of the Robot. The reach adjustment is the one on the side opposite the interconnection board.*

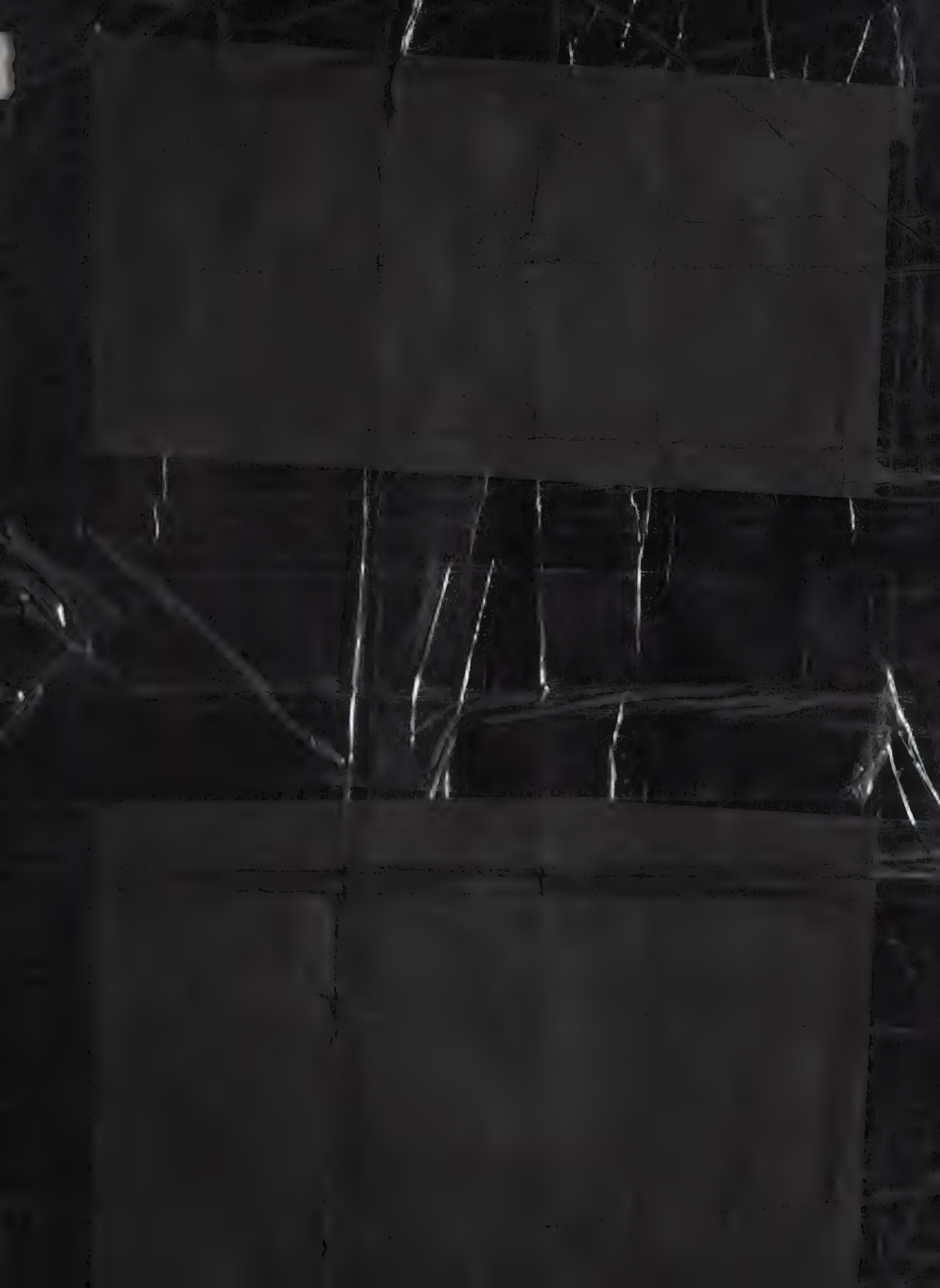


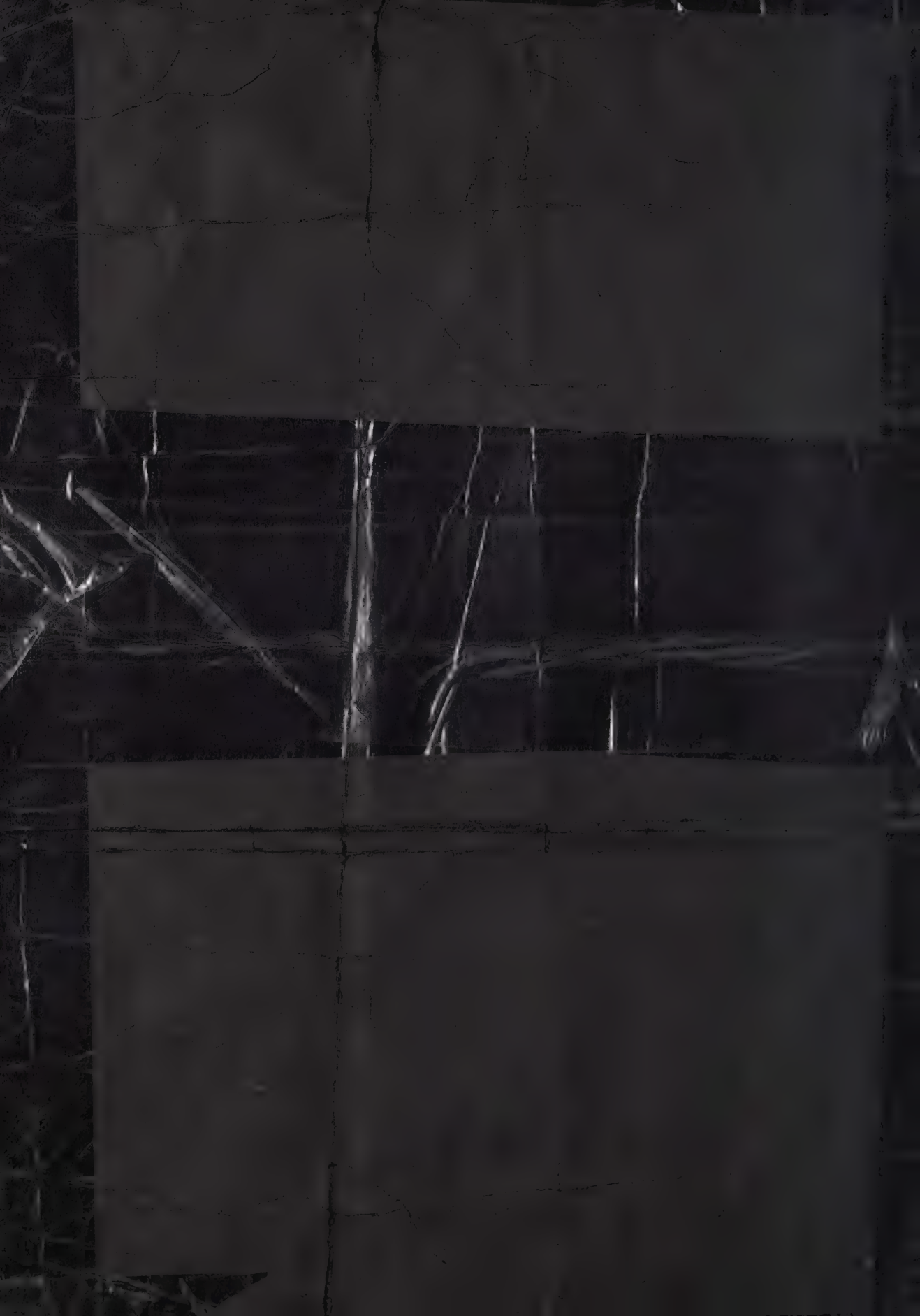
C. DISCONNECT THE MOTOR

1. Carefully snip the cable ties securing the motor leads.
2. Unplug the reach motor leads at the interconnection board.

D. REMOVE THE MOTOR

1. Remove the set screw nearest the motor in the motor drive drum.
   - *The set screw is held in place with Loctite 222®.*
   - *It may be necessary to grasp the Allen wrench with both hands to generate enough force to loosen the set screw.*
2. Remove the four motor mounting screws.
3. Remove the motor.
   - *It may be necessary to push down gently on the left side of the drive drum while removing the motor.*





PROCEDURE 2: INSTALLATION

A. MOUNT THE MOTOR

1. Position the new motor with the electrical terminals to the RIGHT.
2. Using an adjustable wrench, turn the motor shaft until the flat aligns with the set screw hole in the drum when positioned.
3. Slide the motor into position and secure with the the four mounting screws and lockwashers.

   - *It may be necessary to push down gently on the drive drum to align its center hole with the motor shaft while sliding the motor into place.*
   - *A holding screwdriver is helpful in starting the mounting screws.*

4. Sight through the set screw hole and confirm that the motor flat is aligned with the hole.
5. Apply Loctite 222® to the set screw.
   a. Insert the set screw until snug and then loosen 1/8 to 1/4 turn.
   b. With the Allen wrench still in position on the set screw, use one hand to slightly extend and retract the reach by pulling and pushing on the wrist box. Use your other hand to hold onto the Allen wrench.
   c. If properly aligned, contact made between the set screw and the shaft flat (as the drum is moved) will stop the drum from rotating more than 10 degrees or so in each direction. This contact will also be felt through the Allen wrench.
   d. Continue to slowly move the drum while simultaneously tightening down on the set screw. This insures that the set screw is centered on the flat. Tighten securely.

B. CONNECT THE MOTOR

1. Plug the connector into the interconnection board.
2. Dress both sets of motor leads carefully and install a cable tie.

C. SET CABLE TENSION

Choose one of the following methods for setting correct cable tension:

METHOD #1

1. Remove the post clamp (or other arm housing support means).
2. Turn the reach drive cable tensioning adjustment (located on underside of column cap assembly) COUNTER-CLOCKWISE (as viewed from handle end) two turns to retension the cable.

METHOD #2

1. Turn the adjustment several turns CLOCKWISE to fully disengage it.
2. Advance the adjustment COUNTER-CLOCKWISE until a slight resistance is felt. This resistance is the FIRST contact between the adjusting screw and the cable-tensioning device within the column cap assembly.
3. Continue to turn the adjustment COUNTER-CLOCKWISE one more turn.

> *Note: Cables should be approximately equal in tension.*

D. FINALLY

1. Reinstall the skirts.

WRIST BOARD REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the wrist board in the Zymate Robot.

PARTS REQUIRED:

Wrist PC Board, P/N 37190

TOOLS REQUIRED:

Screwdriver, blade, 1/4"
Screwdriver, holding
Steel rule, 12" (or longer)
Square

OPTIONAL:

Robot post clamp, P/N 38236

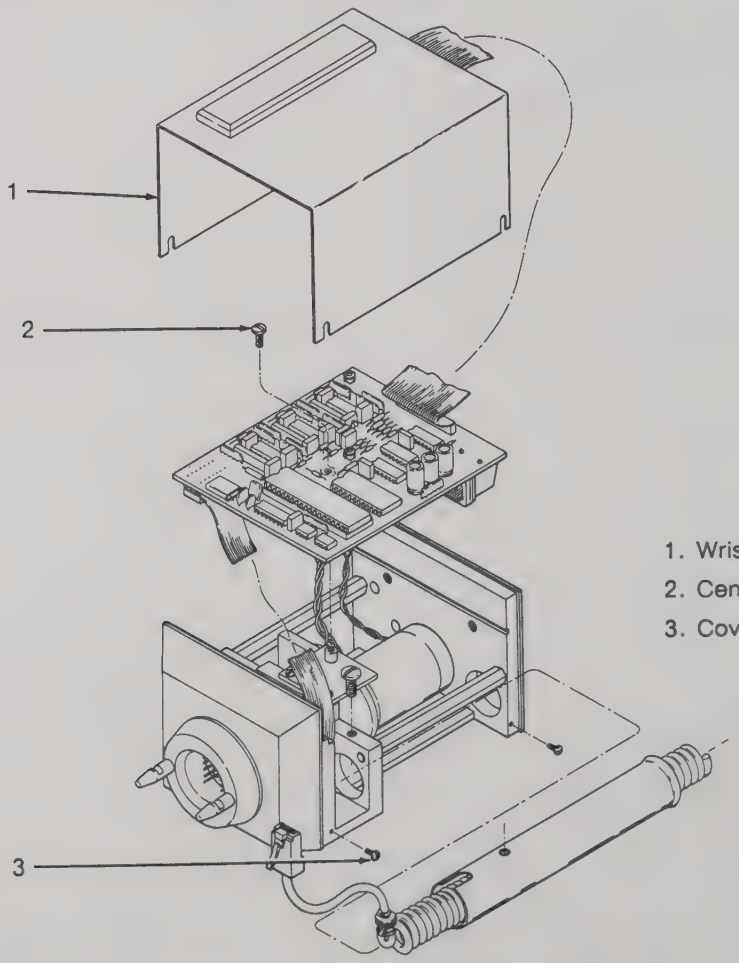
PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.

> *Note: Do not position the arm in a rotary location greater than 360 degrees or less than 0 degrees.*

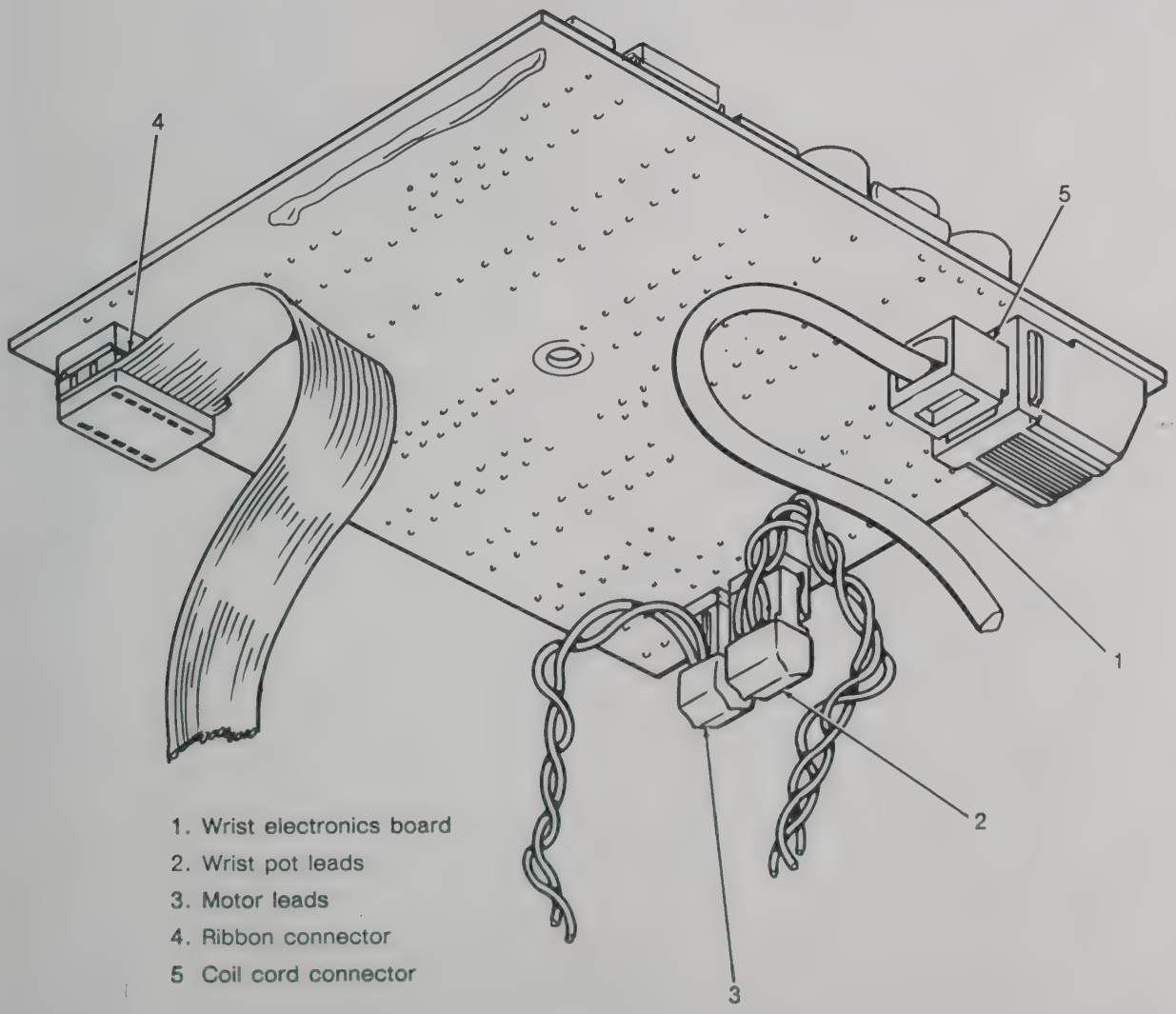
3. Position the arm vertically so that the wrist box is at a convenient working height.
   a. Install a post clamp to temporarily hold the arm housing in this position.
4. Pull the arm to the fully OUT position.
5. Loosen (two turns) the four screws that secure the wrist box cover.
6. Lift the wrist box cover and carefully "hinge" it over onto the arm using caution not to pull the cable from the wrist board.



1. Wrist box cover
2. Center screw
3. Cover screws (4)

B. REMOVE ELECTRONICS BOARD

1. Remove the center screw.
2. Unplug the potentiometer and motor leads.
3. Using a small flatblade screwdriver, pry the ribbon connector on the underside of the wrist board from its socket being careful not to bend its pins.
4. Unplug the coil cord connector.
   a. Push the clip at the rear of the connector down with a small screwdriver.
   b. Pull the connector out.

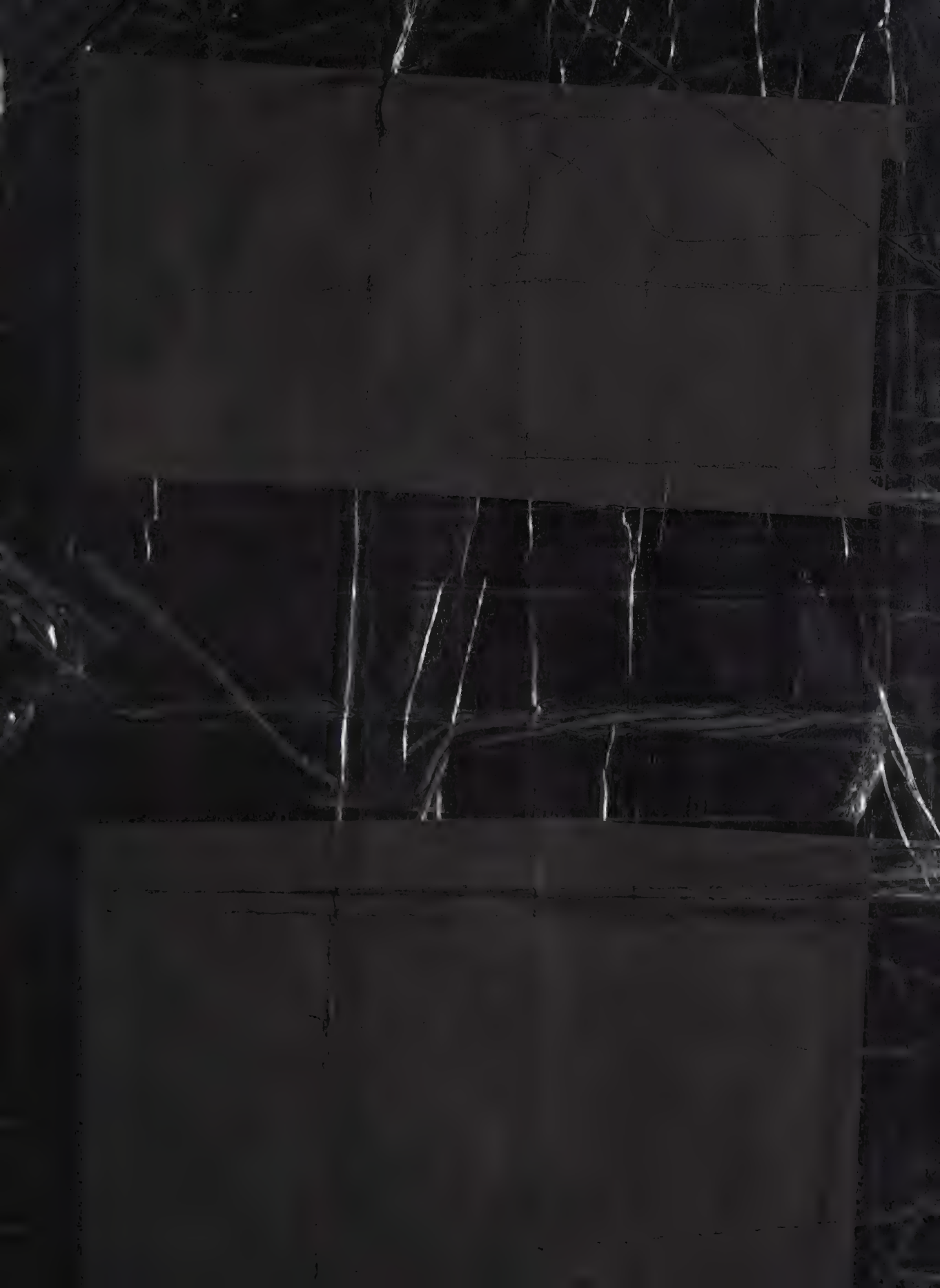


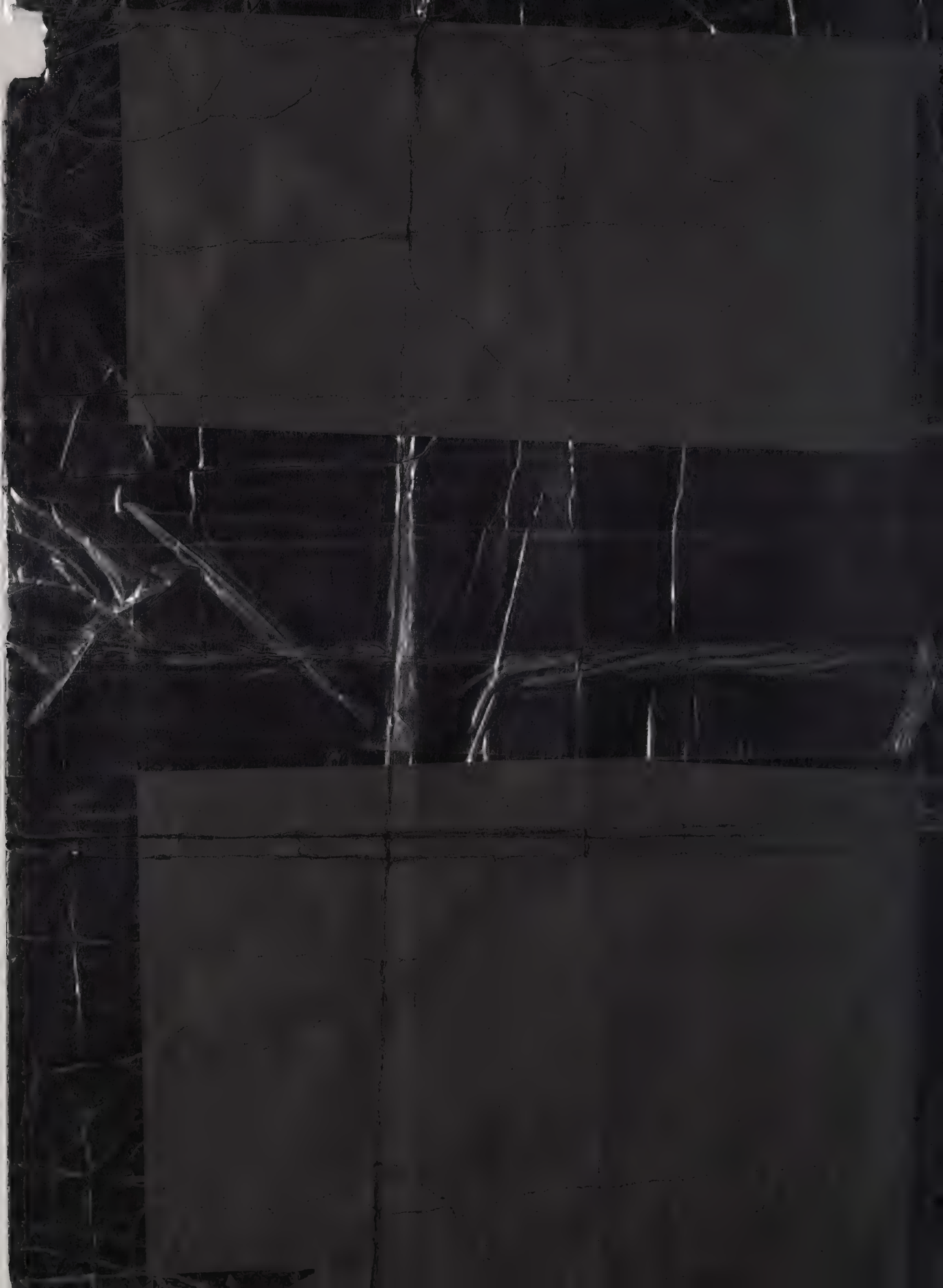
1. Wrist electronics board
2. Wrist pot leads
3. Motor leads
4. Ribbon connector
5 Coil cord connector

PROCEDURE 2: INSTALLATION

A. MOUNT THE BOARD

1. Inspect the new board for obvious defects such as bent pins, loose chips, etc.
2. If the existing wrist cover electronics board is to be reused, unplug it from the old wrist board and connect it to the new wrist board.
3. Connect the potentiometer and motor leads.
4. Press the ribbon connector into its socket taking care not to bend any pins.
5. Plug the coil cord into the connector.
6. Secure the board in place with its screw.
7. Plug in the cover electronics board taking care not to bend any pins.





PROCEDURE 3: GP HAND ADJUSTMENT

A. GP HAND GAIN ADJUSTMENT – ZYMATE II ROBOTS*

With the GP Hand on the wrist:

1. Loosen the four screws securing the cover. Carefully lift the cover and "hinge" it back so that it rests on the Robot arm.
2. Locate the GP Hand gain adjustment pot (R5) in the center of the wrist board.
3. Enter the Robot Hand screen and use the "OPEN" function key to open the fingers 30 units.
4. Using a small flatblade screwdriver, turn the gain pot CW until the fingers oscillate. Then slowly turn the pot CCW until the oscillation just stops. Continue turning the adjustment CCW an additional 1/8 turn.
5. Recheck the gain.
6. Reinstall the wrist cover.

*Zymate I Robots have no GP Hand gain adjustment.

B. WRIST ZERO ADJUSTMENT – ZYMATE I / II ROBOTS

The wrist board may have to be moved slightly to gain access to the screws. If so, use an insulating piece of paper under the board to prevent shorting. Turn OFF Robot power before removing the wrist board screw.

1. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
2. Turn the Robot's power ON. Note that Zymate II Robots also require Controller power to be ON and the wrist angle set to zero degrees.
3. Lay a steel rule across the two wrist coupling pins and carefully measure the distance from each end of the rule to the benchtop.
4. Turn the wrist pot until the two measurements are equal to WITHIN .05 inches per 12 inch rule length.
5. Retighten the adjusting screws until JUST snug.
6. Recheck the wrist zero one more time.

C. FINALLY

1. Turn the Robot's power OFF.
2. Reinstall the wrist cover and tighten the four screws.
3. Turn the Robot's power ON.
4. Turn the Controller power ON.

VERTICAL POTENTIOMETER SERVICE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the precision potentiometer which determines the vertical position of the Zymate Robot.

PARTS REQUIRED:

Vertical potentiometer, P/N 36817
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, Phillips, #1
Screwdriver, blade, 1/4" & 3/8"
Wrench, hex .050 (Allen)
Wire cutters
Digital voltmeter (DVM)
Masking tape
Ruler

OPTIONAL:

Robot post clamp, P/N 38236
Tongue depressor

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Manually position the turntable with the coil cord towards you.
4. Position the arm vertically at approximately 2/3 height.
   a. Install a post clamp to temporarily hold the arm housing in this position.
5. Push the wrist fully IN.

B. DISASSEMBLE THE ROBOT

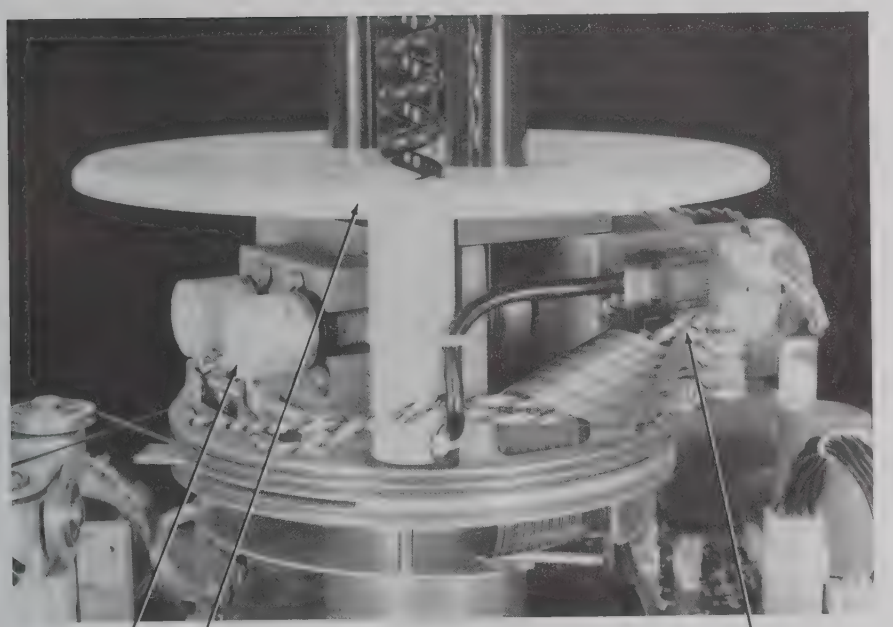
1. Remove both skirts.
2. Remove the turntable cover disk containing the coilcord tube.
3. Unplug the coil cord from the interconnection board.
   a. Press against the clip on the backside of the connector with a small screwdriver to release it.
4. For those Robots with coil cord supports:
   a. Remove the support using a small Phillips screwdriver.
   b. Tape this assembly to the wrist cover.

> *NOTE: CAREFULLY handle the coil cord so that NO TURNS are ADDED or SUBTRACTED as it is moved.*

   c. Push the arm fully out.
5. For those Robots without the coil cord support:
   a. Tape the loose turntable cover to the top of the wrist box.

6. Remove the post clamp and lower the arm housing so that its lower metal flanges are approximately 0.1 inch above the remaining turntable cover.

   a. Support the arm in this position with any convenient means. (Small paper pad, tool, tongue depressor etc.)



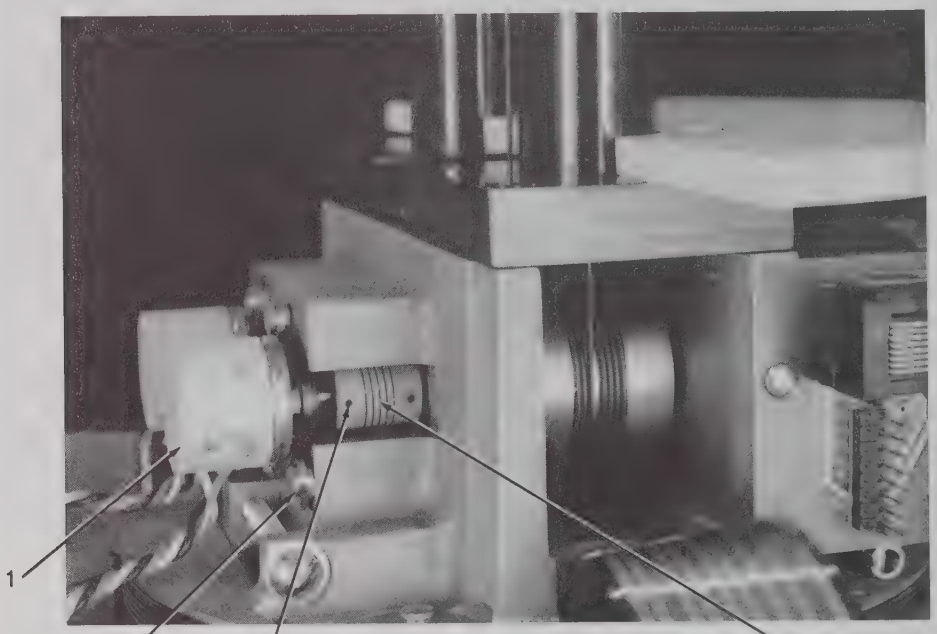
1. Vertical potentiometer
2. Turntable cover with coil cord tube
3. Interconnection board

C. UNFASTEN THE POT

1. Locate the vertical position pot and its flexible shaft coupling.
2. Loosen the coupling set screw NEAREST the pot one turn.

   Move the Robot's arm housing SLIGHTLY if required to access the set screw.

3. Loosen both pot adjusting screws so that the cleats can be turned with the flats FACING THE POT and retighten the screws.



1. Vertical potentiometer
2. Cleat and adjustment screw (2)
3. Flex coupling
4. Set screw

D. REMOVE THE POT

1. Draw the pot outward.
2. Carefully snip the cable tie with wire cutters.
3. Unplug the pot from the interconnection board.
4. Unplug the vertical motor leads from the interconnection board.

PROCEDURE 2: INSTALLATION

A. CONNECT THE POT

1. Plug the new pot into the interconnection board.

> *Note: Do not slide the pot into its flexible coupling at this time.*

2. Dress the pot leads with the reach pot leads.

B. SET THE POT

1. Connect a digital voltmeter (DVM).
   a. "+" lead to pot wiper (black wire).
   b. "–" lead to base plate.
2. Set voltmeter to: Volts, DC, 2V scale.
3. Position the pot with its terminals clear of other objects so its shaft can be easily turned.

> *Note: Make sure that the 0.1" gap between the arm housing and the cover exists.*

4. Turn ONLY the Robot's power ON.
5. Turn the pot shaft until the DVM reads 0.42 volts.
6. Turn the Robot's power OFF.
7. Disconnect the DVM.

C. FASTEN THE POT

1. Position the pot body with its terminals in the 8 o'clock position.
2. Being CAREFUL to avoid turning the pot shaft, slide the pot into its coupling and gently work it into position. (Refer to the photo on page 4 for positioning details.)
3. Loosen both adjusting screws and turn the cleats to engage the flange at the front of the pot body.
4. Tighten both adjusting screws JUST snug.
5. Tighten the coupling set screw.
6. Install a new cable tie.

7. Check that the pot leads are neatly dressed.
8. Plug the vertical motor leads into the interconnection board.

D. REASSEMBLE THE ROBOT

1. Raise the arm housing to the 2/3 height position as before.
2. Reassemble the turntable cover disk.

   Be careful of the coil cord support. Tape in place as necessary.
3. Plug the coil cord into the interconnection board.
4. Reassemble the coil cord support if removed.

PROCEDURE 3: POSITION ADJUSTMENT

Loosening the adjusting screws and cleats will permit the pot body to be turned, changing the Robot's vertical position. This adjustment may be used to:

- Set the vertical position at ZERO; or,
- Reset the vertical to a previously NAMED location to minimize the need for reprogramming after a pot change.

A. ZERO ADJUSTMENT

1. Turn the Robot and Controller's power ON.
   a. Wait for system to initialize.
2. Use the Robot's teaching screen to move the Robot to ZERO height.
3. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
4. By rotating the pot body, move arm housing vertically until the horizontal arm housing parting line is 2.2" above the turntable cover.
5. Retighten the adjusting screws until JUST snug.

B. NAMED LOCATION ADJUSTMENT

1. Turn the Robot and Controller's power ON.
   a. Wait for System to initialize.
2. Use the Robot's teaching screen to move Robot to a NAMED location.
   - *A convenient location is usually a hand attach position. Remove the hand from the station. Move to the attach position. Move the reach IN enough to install the hand in station. Move the reach OUT enough to judge the vertical error.*
3. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
4. Move the arm vertically to the desired height.
5. Retighten the adjusting screws until JUST snug.

C. FINALLY

1. Turn the Zymate Controller's power OFF.
2. Turn the Robot's power OFF.
3. Reinstall the Robot skirts.

SYRINGE HAND ADJUSTMENT PROCEDURE
MODEL #Z910

PROCEDURE SCOPE:

This service procedure covers the gain and zero adjustment for Model #Z910 syringe hands.

PARTS REQUIRED:

None

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8"
Screwdriver, precision flatblade, 1.2 mm

PROCEDURE 1: SYRINGE HAND GAIN ADJUSTMENT

With the Syringe Hand removed from the wrist:

1. Loosen and remove the knob that attaches the syringe plunger to the gear rack mechanism.
2. Place the hand in its parking station and run a program to attach the Syringe Hand.
3. Enter the Hand teaching screen and use the "FILL" function key to raise the gear rack mechanism 10 units.
4. Using a small flatblade screwdriver, turn the gain adjustment pot located on the side of the hand until the rack oscillates. Then slowly turn the adjustment in the opposite direction until the oscillation just stops. Continue turning in the same direction an additional 1/4 turn.
5. Remove the hand and reinstall the knob.

PROCEDURE 2: SYRINGE HAND ZERO ADJUSTMENT

With the Syringe Hand removed from the wrist:

1. Using a small, flatblade screwdriver, remove the 4 screws securing the potentiometer cover in place.
2. Place the Syringe Hand in the parking station and run a program to attach the hand to the wrist.
3. Move the hand to a convenient working spot over the benchtop.
4. From the Hand teaching screen, set the syringe value to 200 units.
5. Slightly loosen the two pot holding screws so that the pot can be finger turned.
6. Turn the pot body until a 1/16 inch gap exists between the bottom of the hand body and the inside of the washer on the lower-end of the gear rack.
7. Tighten the pot adjusting screws, making sure the flats on the cleats face away from the pot.
8. Recheck the zero setting.
9. Reattach the potentiometer cover.

HAND ATTACHMENT & PARKING PROCEDURE

PROCEDURE SCOPE:

This procedure "teaches" the Robot Module those locations necessary for attaching and parking a hand. Additional instruction is provided for properly aligning the hand in the station and the hand station to the Robot wrist to ensure smooth operation.

> *Note: The following procedure does NOT apply to Py Robot's or early Zymate I Robot's that have three servo gain pots located behind the heat sink.*

HAND ATTACHMENT/PARKING BACKGROUND

Attachment and detachment (or "parking") of each hand to the robotic wrist is accomplished using four discreet positions for each hand. These four positions each control a different aspect of hand attaching/parking. The location of these positions with respect to the hand station is critical to smooth and proper operation since the Robot is destination-driven.

These four positions are referred to as:

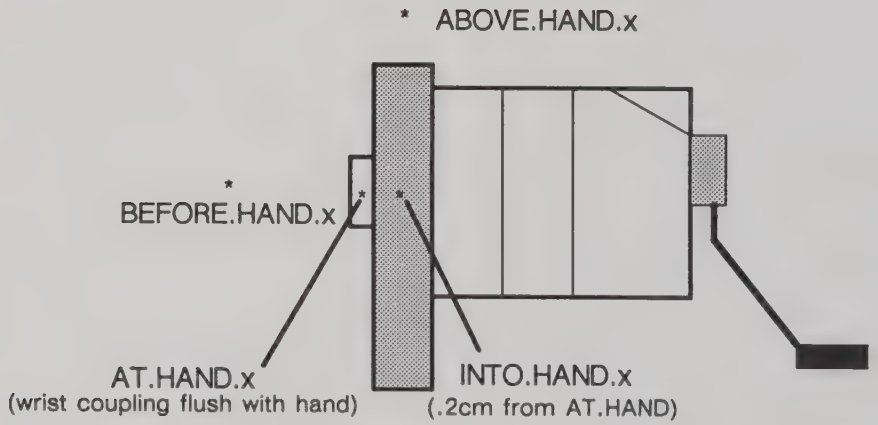
BEFORE.HAND

AT.HAND

INTO.HAND

ABOVE.HAND

The following diagram illustrates their placement relative to the hand station.



These positions are executed in the following order to perform hand attaching or parking:

HAND ATTACH:	HAND.PARK:
BEFORE.HAND	ABOVE.HAND
INTO.HAND	AT.HAND
ABOVE.HAND	BEFORE.HAND

These positions are defined as follows:

1. AT.HAND (absolute position)
   - First position programmed.
   - Has the same height and rotary value as BEFORE.HAND and INTO.HAND.
   - Governs the path the Robot will take going down into the hand station when parking the hand.
   - Places the arm in a position that smoothly guides the hand into the station.
   - REACH-wise, the guide pins in the station and the groove on the side of the hand should align if the hand is moved straight up from this location. If exact parking station-hand alignment cannot be achieved because of station placement, (where exact alignment falls between a single IN-OUT increment in the reach direction), choose the position in the more inward direction.

2. INTO.HAND (relative position)
   - This is the second position programmed. It is .2cm OUT from the AT.HAND position.
   - Has the same height and rotary values as BEFORE.HAND and AT.HAND.
   - This position control how much additional force is necessary to engage the wrist connectors and wrist pins.

3. BEFORE.HAND (relative position)
   - This is the third position programmed.
   - Has the same height and rotary values as the AT.HAND and INTO.HAND positions.
   - It is located a minimum of 5cm IN from the AT.HAND position.

- This position governs the withdrawal motion of the arm from the hand.

4. ABOVE.HAND (relative position)

   - This is the last position programmed for hand attachment and parking.
   - It controls the path the arm takes as it exits from the station with the hand.
   - Has the same ROTARY values as the other three positions. The reach value is 1mm OUT from the AT.HAND reach value to ensure continued engagement of hand to wrist as the hand moves out of the station.
   - The HEIGHT value should be the "working" height value for the benchtop. (Height at which fingers or devices on hand easily clear objects mounted on benchtop.)

PROCEDURE 1: HAND-ROBOT ALIGNMENT

This section checks and corrects wrist/hand mating, provides guidelines for hand station placement on the benchtop, provides instructions for zeroing the wrist pins and aligning the hand horizontally and vertically in the station. Without proper physical alignment, hand attaching and parking will not be smooth and can cause unnecessary wear on parts. If, at any time, hand attaching and parking does not occur smoothly, perform the corrective action described.

A. DETERMINING HAND STATION PLACEMENT

1. Turn the Controller and Robot power OFF.
2. Place the hand station on the benchtop in the approximate location desired for maximum efficiency during the running of the application.

   Do not tape the station down!
3. Push the arm fully IN.
4. Slowly rotate the arm around the benchtop making sure that the station is placed beyond the "elbow" of the arm.
5. Rotate the station so that it is radially aligned to the Robot.
6. Mark its location on the benchtop.
7. Remove the station. Clean the bottom of the station mounting piece and bench with solvent.
8. Apply four pieces of double-sided tape to the bottom of the station mounting piece.
9. Secure the station to the benchtop.
10. Repeat for all hand stations.

B. VERTICAL ALIGNMENT OF THE HAND STATION

1. Using a square, check that the side of the hand station facing the Robot is square to within 0.030 inches.
2. Shim the parking station bottom as required to make the station vertical.

C. HAND/WRIST MATING – With the Robot and Controller power ON:

1. Make sure the station rotation is square with the wrist.
   a. Place the hand in the parking station.
   b. From the Robot teaching screen, extend the reach of the arm OUT until the hand is attached.

c. Sight down on the mating surface of the wrist and hand.

d. Make sure there is no angled gap between these two surfaces.

e. Adjust by rotating the parking station (loosen the black knob and twist the station) until the wrist contacts the parked hand along the entire edge of the mating surface. Retighten knob.

2. Verify that the wrist attaches freely to the parked hand.

   a. Run a program to attach and park the hand.

   b. Check that the wrist/hand mating is smooth.

D. WRIST ALIGNMENT

For Zymate I Robots:

1a. Turn the Controller's power OFF.

2a. Momentarily cycle (ON – OFF – ON) the Robot's power to zero the wrist.

For Zymate II Robots:

1b. Turn the Robot's power ON.

2b. Turn the Controller's power ON and set the wrist angle to zero.

3. Position the arm so that the wrist box is at a convenient working height close to the parking station.

4. Grasp the wrist box and gently rock it back and forth to center the arm in its bearings. (Refer to procedure R14 – reach bearing adjustment section in the Service Manual to tighten and adjust these bearings if necessary.)

5. Lay a long steel rule across the wrist pins and measure the distance to the bench top at each end of the rule. (Maximum allowable error is 0.05 inches per 12 inches of rule length.)

6. If the maximum allowable error is exceeded, adjust the wrist pins using the wrist potentiometer inside the wrist box. (Refer to the wrist zero section in Maintaining the Zymate I or II System).

   a. Loosen the four screws securing the wrist box cover and carefully flip the cover over onto the arm.

   b. Using a long thin flatblade screwdriver, loosen the adjusting screws just enough so the pot body can be finger-turned. (There are two holes located on the back of the wrist box that provide access to these screws with a screwdriver.)

   c. Turn the wrist potentiometer until the two measurements are as equal as possible. This usually takes several tries!

d. Retighten the adjusting screws until just snug.

e. Reattach the wrist box cover.

E. HAND IN PARKING STATION

This procedure:

- Adjusts the detents so they provide a positive capture of the hand in the station.
- Adjusts the guide pins so they guide and locate the hand properly in its station.

1. Place the hand in its parking station.
2. Using a blade screwdriver, turn both DETENTS until they do NOT contact the hand.
3. Using a 3/32 Allen wrench, adjust the four guide pins to:
   - Firmly guide the hand.
   - Center the hand in the station.
   - Make sure the bottom of the hand sits FLAT on the parking station.
   - Provide some tightness when sliding the hand into and out of the parking station.
4. Loosen the two guide pins on one side 1/8 turn.
5. Adjust the DETENTS.
   a. Turn one detent CW until it produces a GENTLE snap action when the hand moves in and out of the station.
   b. Turn this detent EXACTLY 1/2 turn CCW to disable the action.
   c. Adjust the other detent to obtain a gentle snap action.
   d. Turn the first detent 1/2 turn CW so that both detents are now contributing to an overall gentle, snap action.

> *Note: Blank hands generally require more detent action to hold hand in the station.*

PROCEDURE 2: TEACHING POSITIONS

This section describes the locating of the positions for smooth and efficient parking and attaching of hands. Refer to the description at the beginning of this procedure for additional information on the hand attachment/parking positions.

1. Turn the Robot and Controller power ON.
    a. Wait for the Robot to initialize. (For Zymate II Robots, go to the Robot teaching screen and set the wrist angle to zero).
2. Guide the two wrist pins into the brass inserts in the hand using the function keys on the Controller or the teach pendant.
    a. Pay particular attention to the vertical and rotary positioning.
    b. Center the wrist pins as carefully as possible. If you must make a choice between 1mm too high or low, choose the lower position. The wrist pins will slide against the smooth bottom rather than the slotted top when entering the hand.
    c. Note the HEIGHT value as displayed on the Robot screen.
    d. Move the arm upward until the hand just clears the station.
    e. Make sure hand is fully engaged with the wrist by pushing slightly against the hand towards the Robot.
    f. Move the arm IN or OUT as necessary to align the guide pins in the station with the grooves on the sides of the hands.
    g. If they don't align perfectly, select the slightly IN position.
3. Set and name the AT.HAND position:
    a. Move the arm straight down until it is at the height noted in step 2a.
    b. Name this absolute position AT.HAND.
    c. This position is part of the PARK.HAND program.
4. Set and name the INTO.HAND position:
    a. Strike the OUT key two times.
    b. Name this relative position INTO.HAND.
    c. This position is part of the GET.HAND program.
5. Set and name the BEFORE.HAND position:
    a. Use the IN key to move the arm in until the wrist pins are clear of the hand.
    b. Name this relative position BEFORE.HAND.

6. Move to the AT.HAND location using the "Move to Location" function.

    a. Strike the OUT key one time.

7. Set and name the ABOVE.HAND position:

    a. Move the hand using the UP key until it is completely clear of the hand station. (If a common working height is being used, move the hand up to this height.)

    b. Name this relative position as ABOVE.HAND.

8. Name the WRIST hand position.

    a. From the Robot teaching screen, select the HAND SCREEN.

    b. Using function 7 (MOVE TO COORDINATES) set the wrist and hand values to zero (0).

    c. Using function 5 (NAME HAND POSITION) name these settings as WRIST.0.

9. Verify attaching smoothness and fine tune as necessary.

    a. Using the "Move to Location" function, attach the hand using this sequence of commands:

        BEFORE.HAND

        AT.HAND

        ABOVE.HAND

    b. Observe the smoothness of the hand as it enters the parking station. If it is rough, verify that the groove and guide pins align. Adjust the AT.HAND position accordingly.

    c. Verify that the wrist coupling is "just flush" with the rear of the hand. If there is a large gap, move the AT.HAND position OUT 1mm.

10. Verify parking smoothness and fine tune as necessary.

    a. Using the "Move to Location" function, park the hand using this sequence of commands:

        ABOVE.HAND

        AT.HAND

        BEFORE.HAND

        Observe the smoothness of the hand as it enters the parking station. If it is rough, verify that the groove and guide pins align. Adjust the AT.HAND position accordingly.

    b. Verify that the wrist coupling is "just flush" with the rear of the hand. If there is a large gap, move the AT.HAND position OUT 1mm.

ROTARY DRIVE CABLE REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the rotary drive cables in the Zymate Robot's rotary pulley mount assembly.

PARTS REQUIRED:

Fixed End Cable, 73 1/4" P/N 36085
Tensioning Screw Cable, 67 1/4", P/N 36084

TOOLS REQUIRED:

Screwdriver, flatblade, 1/4
Screwdriver, flatblade, 3/16
Screwdriver, holding
Wrench, hex (Allen), 3/32
Wire cutters (dikes)
Loctite 222®
Masking tape
Flashlight or penlight

OPTIONAL:

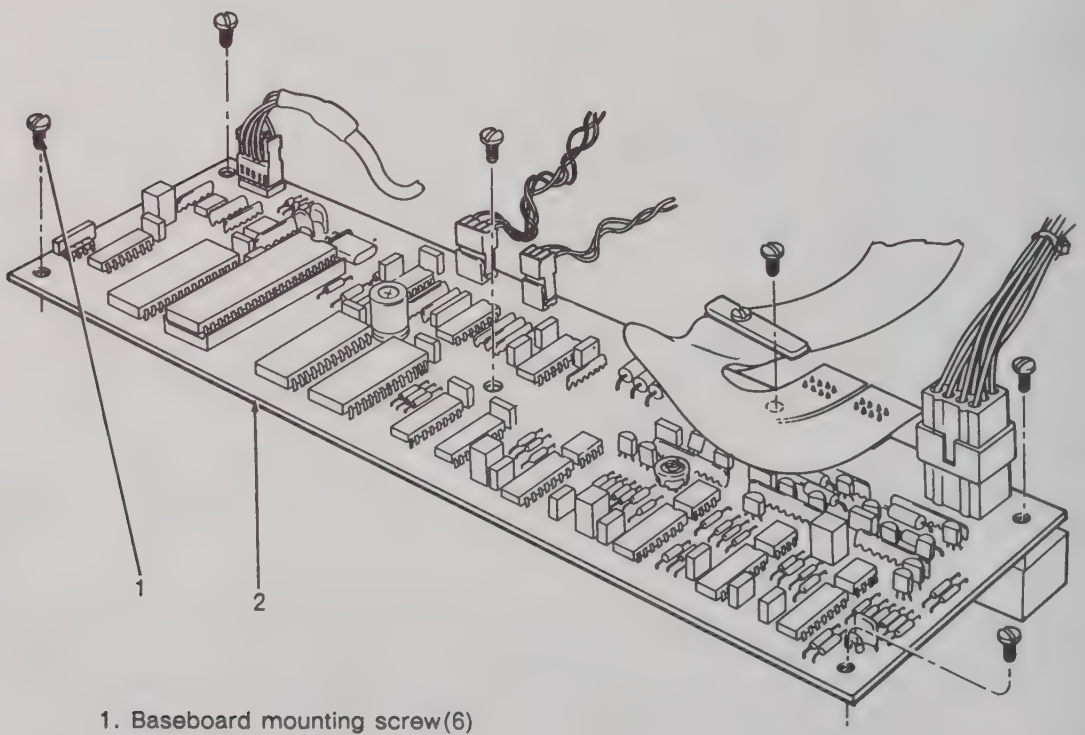
Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and disconnect the power cord.
3. Move the arm vertically to mid-height. Install a post clamp (or other means of support) to hold the arm in this position.
4. Rotate the arm to the 180 degree position.
5. Disconnect the six cables from the baseboard.
6. Remove the six baseboard mounting screws, lift the baseboard off its mounting standoffs and set aside.

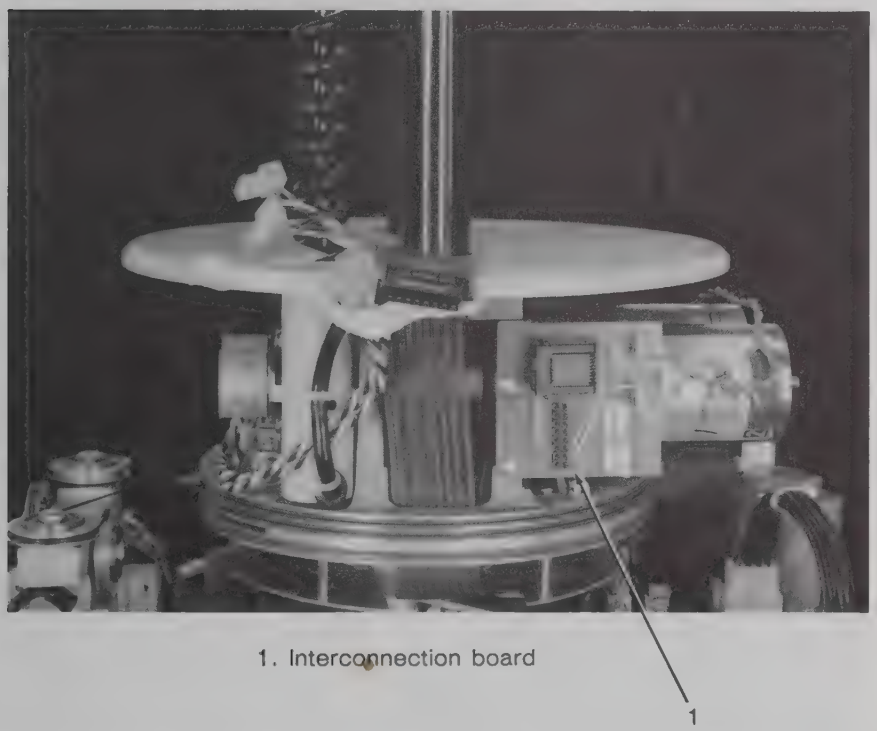


1. Baseboard mounting screw(6)
2. Baseboard

7. Unplug the potentiometer, motor and ribbon connectors from the interconnection board.

8. Using a small screwdriver, push against the clip at the rear of the coil cord connector and unplug the coil cord from the interconnection board. Tape all loose connectors to the turntable cover.

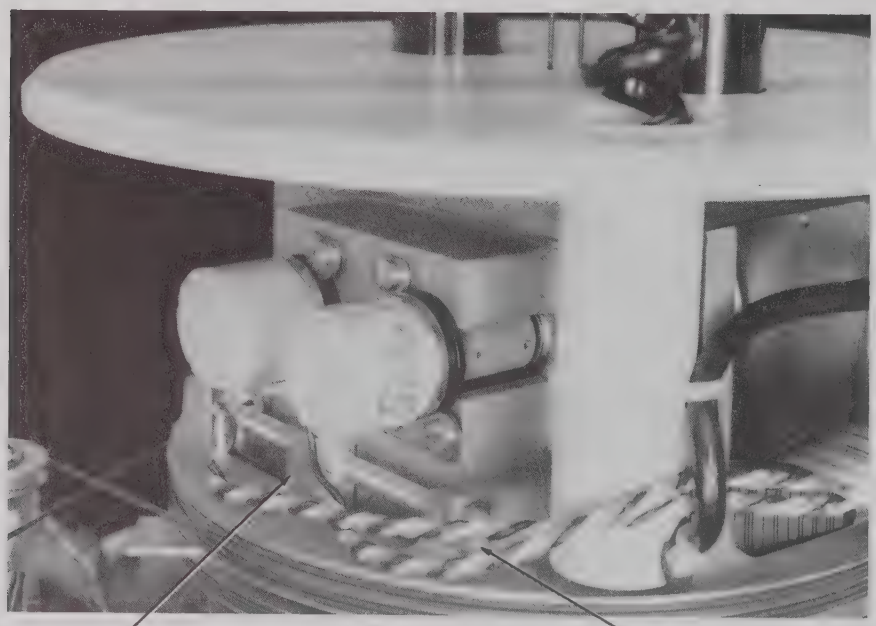
9. Remove the two screws securing the interconnection board to the turntable and set the board aside.



1. Interconnection board

B. REMOVE THE TENSIONING SCREW CABLE

1. Release tension on the cable by turning the rotary cable tensioning screw COUNTER-CLOCKWISE.
2. Continue turning the screw until the tension adapter block has moved to the point where the cable ferrule can be easily removed from the block.



1. Tension adaptor block
2. Rotary cable tensioning screw

3. Remove the cable by pulling the ferrule through the hole in the turntable and unwrapping the cable.

C. REMOVE THE FIXED END CABLE

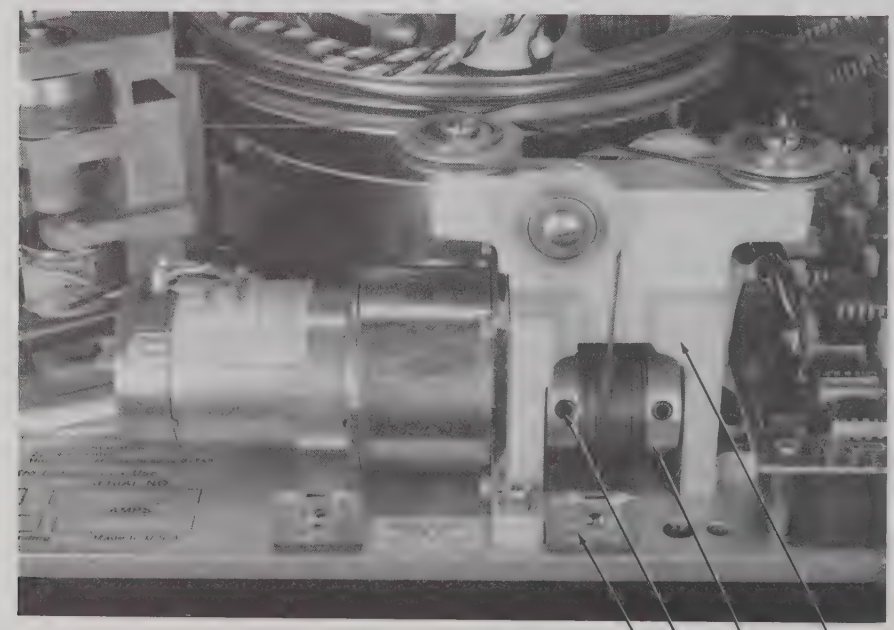
1. Release tension on the cable by manually rotating the arm COUNTER-CLOCKWISE.
2. Lift the spring cable connector off the roll pin post.
3. Remove the cable end from the spring cable connector and set the connector aside.
4. Unwrap the cable from the turntable.

1. Roll pin post
2. Spring cable connector
3. Fixed end cable

D. REMOVE THE ROTARY DRIVE DRUM

With the set screws in the drum facing outward as in the photo below:

1. Using the 3/32 Allen wrench, remove the two set screws from the drum.
2. Using a small flatblade screwdriver, gently pry the shaft on the right side of the drum part-way out (1/4 to 3/8 inch).
3. Remove the four motor mounting screws and washers.
4. Slide the motor out of the pulley mount assembly.
5. Pull the shaft the rest of the way out of the drum.
6. Locate the "L" shaped skirt bracket nearest the drum in the pulley mount assembly. Using a flatblade screwdriver, loosen the screw securing the bracket and slide the bracket from the base (this allows access to the drum).
7. Remove the drum from the pulley mount assembly.
8. Unwrap both cables from the drum.

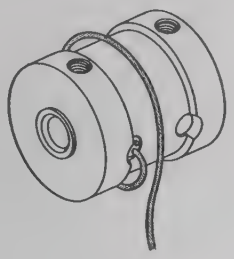


1. Skirt bracket
2. Set screw(2)
3. Rotary drive drum
4. Pulley mount assembly

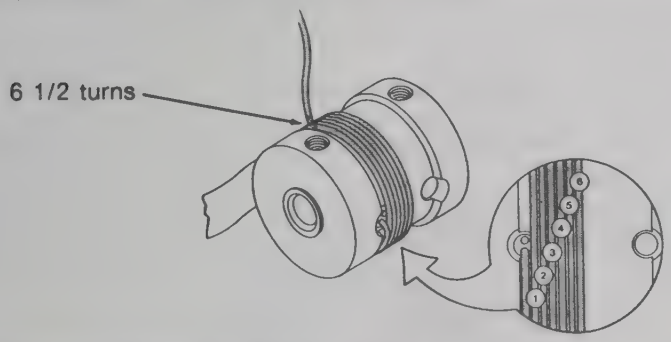
PROCEDURE 2: INSTALLATION

A. WRAP FIXED END CABLE (Longer cable)

1. Prepare two pieces of tape 1 1/8 inches long.
2. Holding the drum with the set screw holes positioned above the ferrule holes, insert one end of the longer cable into the left ferrule hole.

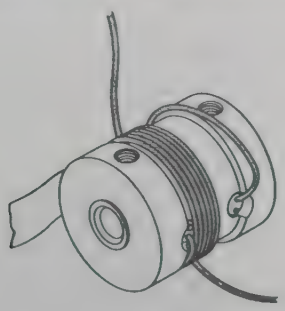


3. Wrap the cable DOWN and UNDER the drum for 6 1/2 turns. Use the ferrule hole as a reference point.
4. Secure the cable in place by using one of the pieces of tape. Be sure not to cover the right section of the drum with the tape.

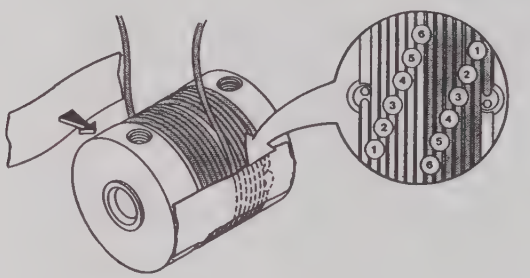


B. WRAP TENSIONING SCREW CABLE (Shorter cable)

1. Holding the drum as before, insert one end of the shorter cable into the right ferrule hole.

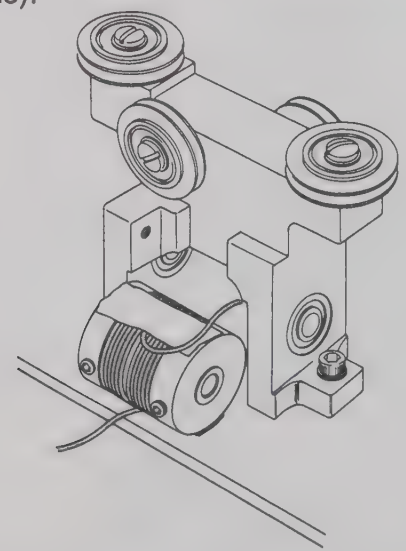


2. Wrap the cable UP and OVER the drum for 6 full turns, again using the ferrule hole as a reference point.
3. Secure the shorter cable by placing the second piece of tape perpendicular to the direction of the cable wraps, directly over the two ferrule holes. Do NOT extend the tape onto the flat ends of the drum.
4. Carefully remove the first piece of tape (from step A, 4) and place it so that it runs parallel to the second piece. Make sure it is positioned 180 degrees opposite the second piece of tape.



C. REINSTALL THE ROTARY DRIVE DRUM

1. Orient the drum near the outer opening in the pulley mount assembly so that the two set screw holes face upward, with the longer cable located nearest the turntable.
2. Insert the longer cable through the outer opening in the pulley mount assembly.
3. Place the drum in the pulley mount assembly with the set screw holes facing out (away from the turntable).



4. With the flat facing outward, insert the shaft through the bearing and into the right side of the drum.

5. With the motor shaft flat facing outward and the motor terminals up, slide the rotary motor into position through the left side of the drum. Using the holding screwdriver, secure the motor with the four screws and washers previously removed.

6. Center the drum in the pulley mount assembly.

7. If possible, use a flashlight to sight through the set screw holes and verify that the motor shaft flat faces outward.

8. Apply a drop of Loctite 222® to the threads of one of the set screws and insert it into the hole on the motor side of the drum. Tighten until snug.

9. Verify that the set screw is aligned with the shaft flat on the motor by doing the following:

   a. Loosen the set screw 1/8 to 1/4 turn. (Keep the Allen wrench in position on the set screw).

   b. Place a finger on the tail shaft protruding from the left end of the motor.

   c. Using the Allen wrench as a lever, rotate the drum back and forth (approximately 10 degrees) in each direction. If properly aligned, contact made between the set screw and the shaft flat as the drum is rotated will stop the drum from rotating more than 10 degrees or so in each direction. Also, the tail shaft of the motor will move slightly each time contact is made.

   d. Continue to slowly rotate the drum while simultaneously tightening down on the set screw. This insures that the set screw is centered on the flat. Tighten securely.

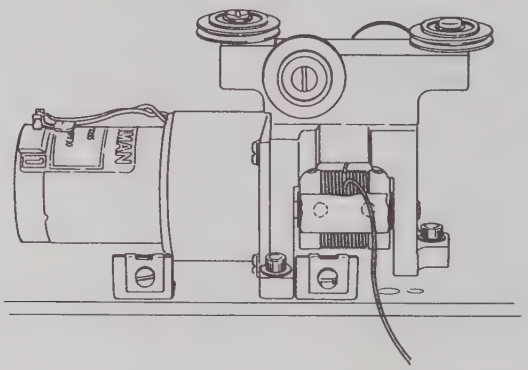
   e. If the tail shaft did not move and contact was not made, remove the set screw and motor. Repeat steps 5–9.

10. Sight through the right hole in the drum and verify that the shaft flat is aligned with the the hole opening. If necessary, turn the motor tail shaft to rotate the drum to a position that will allow for easier sighting. Turn the end of the shaft until the flat aligns with the hole.

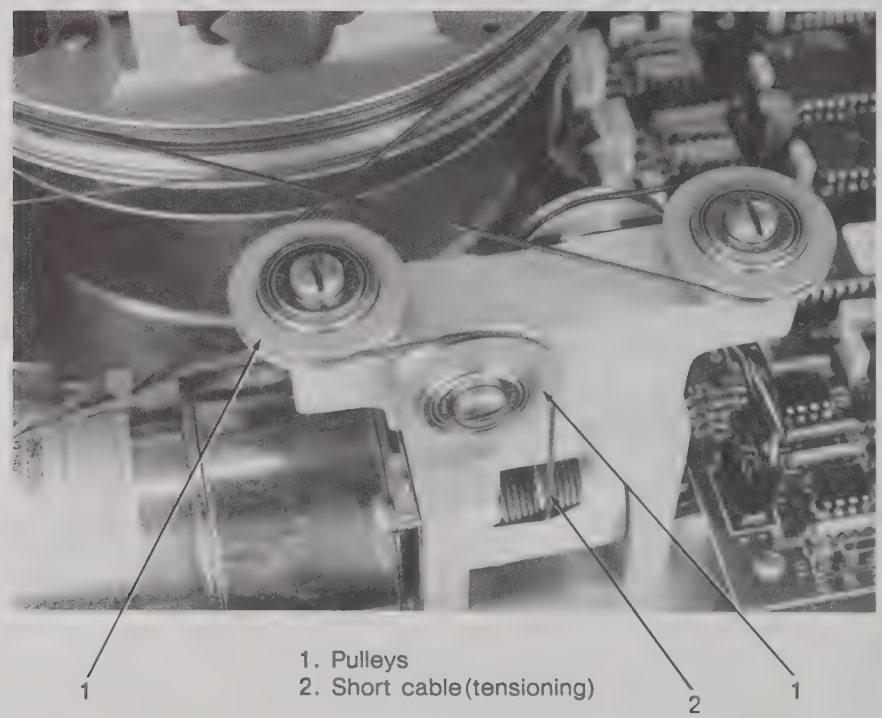
11. Apply Loctite 222® to the second set screw, insert it into the hole on the right side of the drum and tighten it securely against the flat.

D. DRESS THE CABLES OVER THE PULLEYS

1. Turn the motor tail shaft COUNTER-CLOCKWISE until the two set screws in the drum face UP.

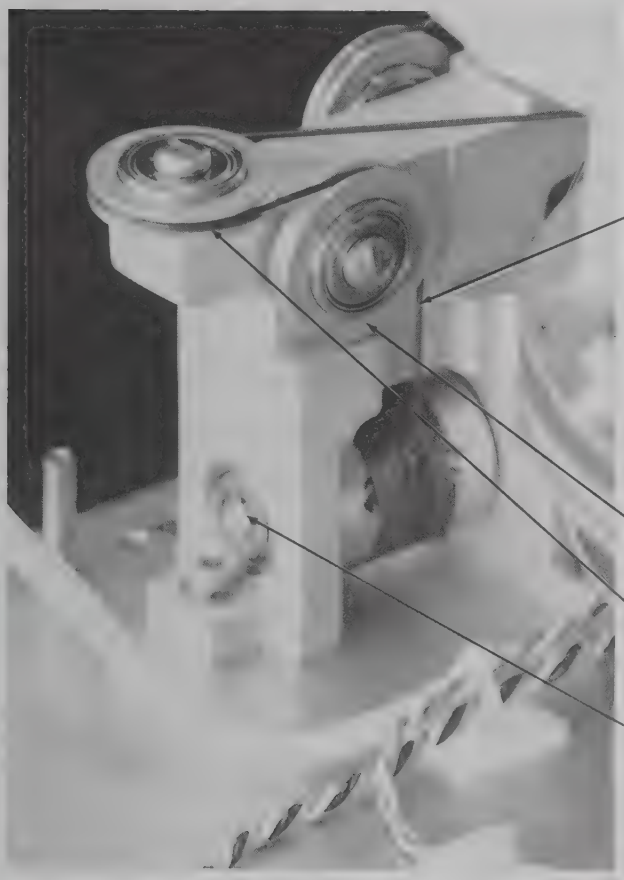


2. While facing the pulley mount assembly, wrap the front (short) cable around the front and top left pulleys as shown below. Secure the cable to each pulley with a piece of tape.



1. Pulleys
2. Short cable (tensioning)

3. Wrap the rear (long) cable around the rear and top right pulleys as shown below. Secure the cable to each pulley with a piece of tape.



1. Shaft
2. Pulleys
3. Long cable (fixed-end)

E. WRAP THE FIXED CABLE AROUND THE TURNTABLE

1. Manually rotate the arm COUNTER-CLOCKWISE from the 180 degree position to approximately 150 degrees. This increases the effective cable length, facillitating the wrapping procedure.
2. Wrap (from the middle down) the longer, fixed-end cable CLOCKWISE around the top groove of the turntable approximately 2 1/4 turns. Maintain tension on the cable, taping it in place if necessary.
3. Insert the cable end through the lower-left hole in the turntable's top groove.
4. Insert the cable end into the cable spring connector.
5. Slide the cable spring connector over the roll pin post.
6. Being careful not to allow any turning of the rotary drive drum, rotate the turntable CLOCKWISE to remove any slack in the cable.

F. WRAP THE TENSIONING SCREW CABLE AROUND THE TURNTABLE

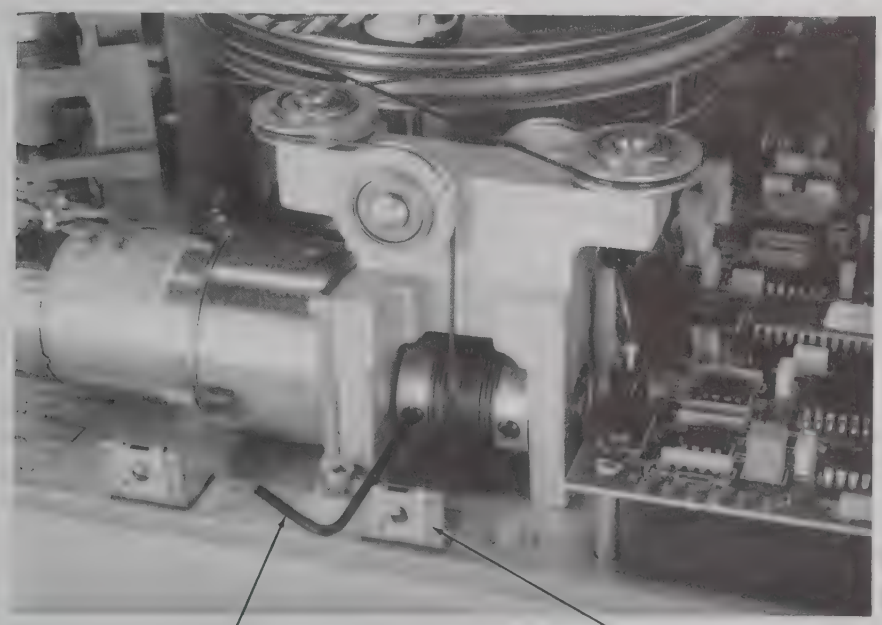
1. Wrap (from the middle up) the shorter, tensioning screw cable COUNTER-CLOCKWISE around the top groove of the turntable approximately 2 turns.
2. Insert the cable end through the upper-right hole in the turntable's top groove. Slacken the upper two rows of the cable to facilitate the insertion. Do NOT use metal-tipped tools to slacken the cable. Use your fingers, nylon screwdriver, or nylon tweezers.
3. Insert the cable end into the slot in the tension adapter block. If necessary, turn the rotary cable tensioning screw COUNTER-CLOCKWISE allowing the cable end to be easily inserted.
4. Once inserted, turn the rotary cable tensioning screw CLOCKWISE until any visible cable slack is JUST removed.
5. Reinstall the "L" shaped skirt bracket into position near the opening of the pulley mount assembly.

PROCEDURE 3: ADJUSTMENT AND REASSEMBLY

A. CABLE ADJUSTMENT

1. Remove any tape used during cable installation.
2. Insert the 3/32 Allen wrench into the left set screw in the drum.

   The wrench acts as brake lever during the tensioning operation.
3. Push the wrist box in a CLOCKWISE direction using approximately 5 lbs. of force. Observe that the Allen wrench stops further rotation by hitting the skirt bracket.
4. Turn the rotary cable tensioning screw CLOCKWISE to remove any visible cable slack.
5. Check the cable tension:
   a. Grasp the longer of the cable sections between the turntable and pulley mount assembly and pull the cable sideways.
   b. A force of approximately 2 lbs. should move the cable .04 to .08 inch (.1 to .2cm). When correctly tensioned, this cable should feel tight.
6. Make any necessary adjustments to attain the tension requirements in step #5b.
7. Remove the Allen wrench.



1. Allen wrench
2. Skirt bracket

B. REASSEMBLE THE ROBOT

1. Replace the interconnection board.
2. Connect all interconnection cables.
3. Reinstall the baseboard with the six screws.
4. Plug in the six baseboard connectors.
5. Reinstall the skirts.

ANTI-BACKLASH GEAR INSTALLATION PROCEDURE

PROCEDURE SCOPE:

This procedure describes the steps necessary to install an anti-backlash gear assembly in the wrist of a Zymate Robot.

Installation of this gear is recommended if the wrist overcorrects when gently rotated by hand in each direction.

PARTS REQUIRED:

Anti-backlash gear and hub assembly, P/N 37321

TOOLS REQUIRED:

Screwdriver, blade, 1/4"
Screwdriver, precision, 1.2mm
Allen Wrench, .050"
Needlenose pliers

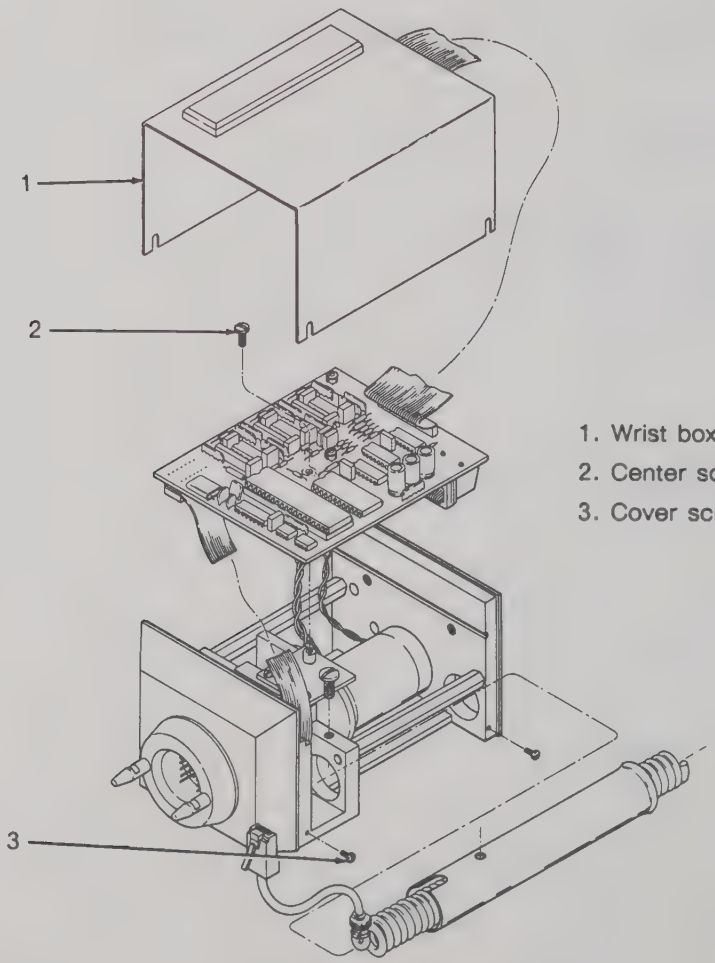
OPTIONAL:

Robot post clamp, P/N 38236

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

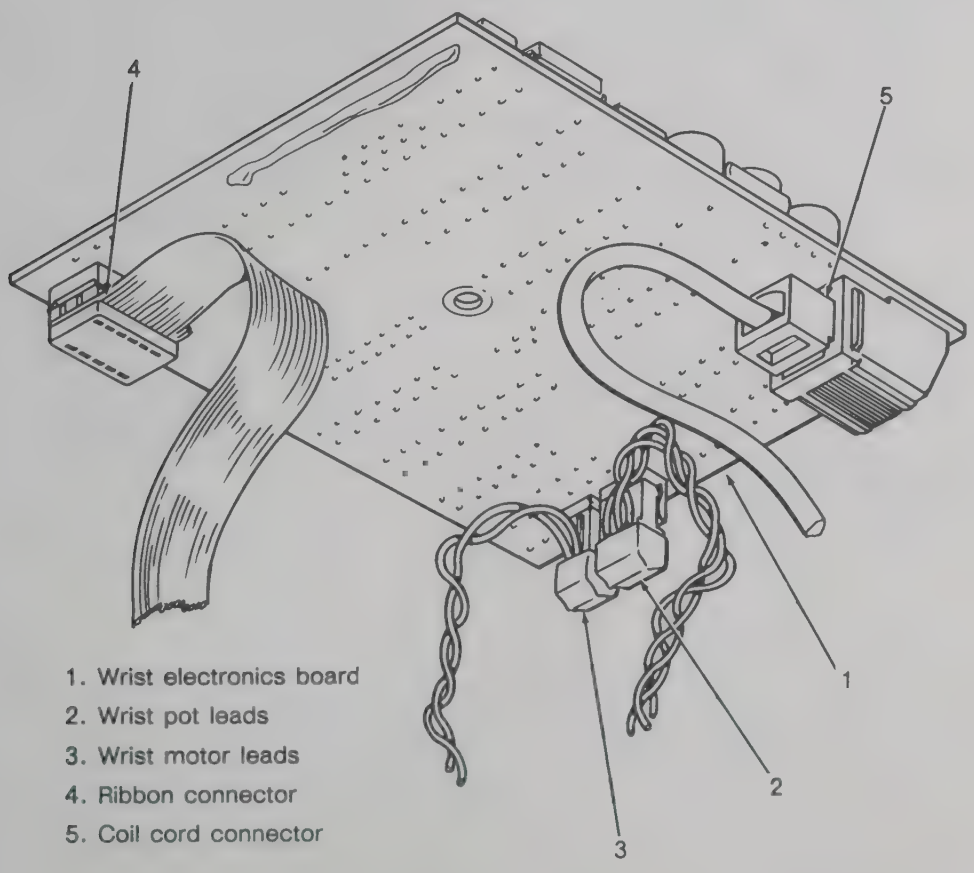
1. From the Robot teaching screen, set the wrist angle to zero.
2. Turn the Controller's power OFF.
3. Turn the Robot's power OFF.
4. Position the arm in a convenient working location over the benchtop. If necessary, install a post clamp to temporarily hold the arm housing at a desirable working height.
5. Loosen the four screws that secure the wrist box cover.
6. Lift the wrist box cover and carefully "hinge" it over onto the arm.



1. Wrist box cover
2. Center screw
3. Cover screws(4)

B. REMOVE THE BOARD AND WRIST COVER ASSEMBLY

1. Remove the center screw from the wrist electronic board.
2. Carefully lift the board from the wrist box to allow access to the four connectors on the bottom side of the board.
3. Unplug the potentiometer and motor leads.
4. Using a small flatblade screwdriver, pry the ribbon connector from its socket.
5. Using the same screwdriver, push against the clip at the top of the coil cord connector and unplug the cord.
6. Maintaining the ribbon cable connection between the wrist electronics board and the wrist cover board, carefully remove the wrist cover assembly and wrist electronics board and set aside.



1. Wrist electronics board
2. Wrist pot leads
3. Wrist motor leads
4. Ribbon connector
5. Coil cord connector

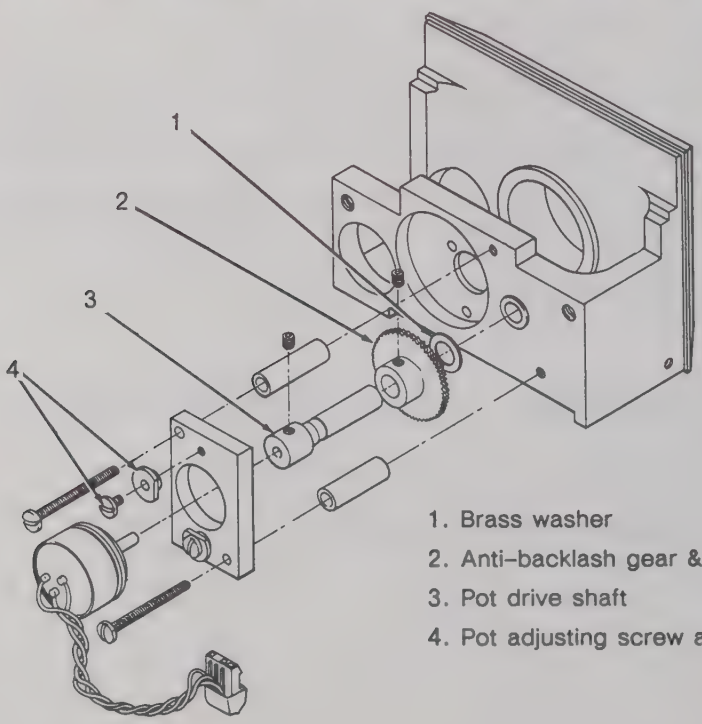
C. UNFASTEN AND REMOVE THE POT

1. Locate the wrist pot and the wrist pot drive shaft.
2. Loosen the set screw on the wrist pot drive shaft. If necessary, carefully turn the wrist coupling slightly to access the set screw.
3. Loosen both pot adjusting screws so that the cleats can be turned.
4. Turn the cleats until their flats face toward the pot and retighten the screws.
5. Draw the pot outward.

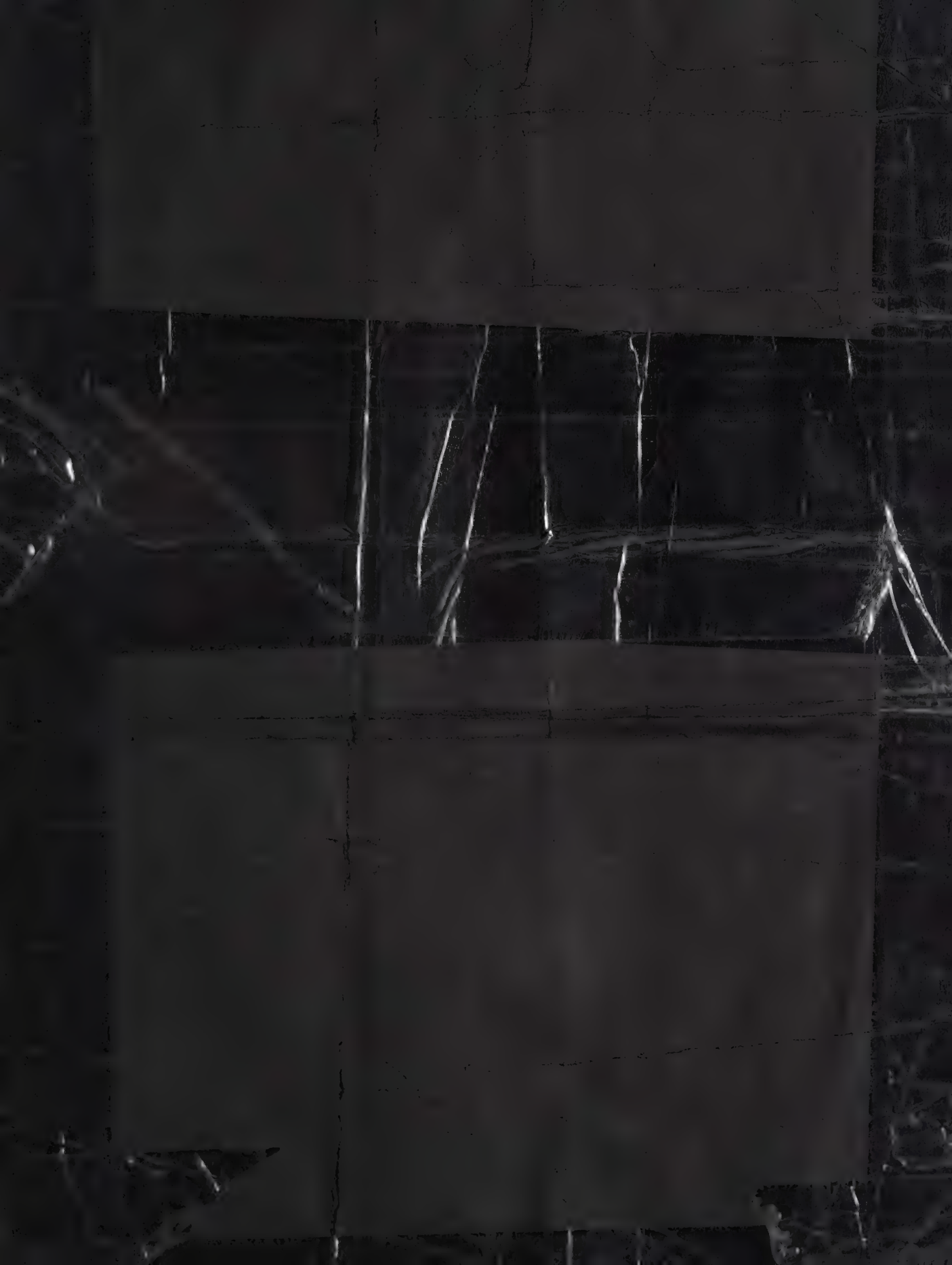
> *Note: Do NOT turn the pot shaft while removing pot. This will insure that the pot maintains a reasonably accurate wrist zero setting when reassembling the wrist.*

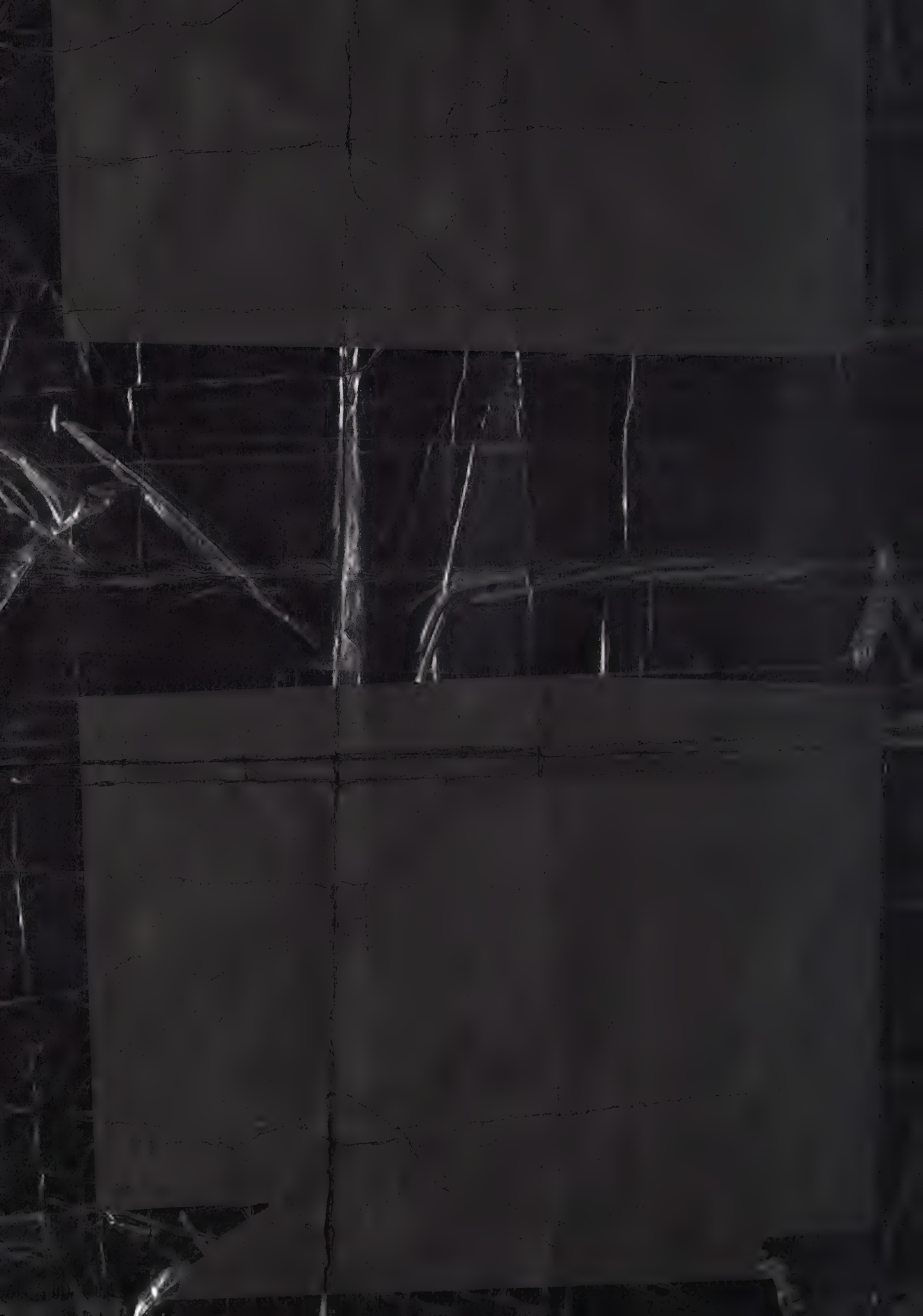
D. REMOVE THE GEAR ASSEMBLY

1. Loosen the gear and hub assembly set screw one turn.
2. Withdraw the pot drive shaft through the hole in the pot mounting plate.
3. Withdraw the gear and hub assembly.
4. Remove the brass washer (if any) from the front of the gear and hub assembly.



1. Brass washer
2. Anti-backlash gear & hub assembly
3. Pot drive shaft
4. Pot adjusting screw and cleat (2)





PROCEDURE 2: INSTALLATION

A. CHANGE GEARS

1. Insert the new anti-backlash gear and hub assembly into approximate position next to the motor gear.
2. Insert the pot drive shaft through the hole in the pot mounting plate and push it part-way through the gear and hub assembly.
3. Using the needlenose pliers, hold the brass washer in position at the front of the gear and hub assembly. Fully insert the pot drive shaft until it pushes through the washer and secures itself in the bearing within the wrist box housing.
4. Turn the gear and hub assembly until the set screw faces UP.
5. Mesh the anti-backlash gear teeth with the motor gear teeth by using a small screwdriver to move the two anti-backlash gears until the teeth align, allowing the gears to grip the teeth on the motor gear.
6. Turn the pot drive shaft until its set screw aligns with the set screw on the gear and hub assembly (both facing UP).
7. Securely tighten the gear and hub assembly set screw.

B. REINSTALL POT

1. Reinsert the pot, being careful not to turn the shaft.
2. Loosen the pot adjusting screws so the cleats can be repositioned.
3. After realigning the cleats so the flats face away from the pot, tighten both screws.
4. Check to be sure both anti-backlash gears remain centered within the motor gear, and that the spring on the anti-backlash gear clears the housing wall.
5. Tighten the set screw on the pot drive shaft.

C. REINSTALL WRIST BOARD AND WRIST COVER ASSEMBLY

1. Plug the four connectors into the wrist electronics board.
2. Secure the board to the wrist box with the center screw.

PROCEDURE 3: POSITION ADJUSTMENT

A. WRIST ZERO ADJUSTMENT

Move the wrist board slightly to gain access to the screws. Use an insulating piece of paper under the board to prevent shorting. Turn OFF Robot power before removing the wrist board screw.

1. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
2. Turn the Robot's power ON.

> *Note: Zymate II Robots also require that Controller power be ON and the wrist angle set to zero degrees.*

3. Lay a steel rule across the two wrist coupling pins and carefully measure the distance from each end of the rule to the benchtop.
4. Turn the wrist pot until the two measurements are equal to within .05 inches per 12 inch rule length.
5. Retighten the adjusting screws until JUST snug.
6. Recheck the wrist zero by performing steps 3 – 4 above.

B. FINALLY

1. Turn the Robot's power OFF.
2. Reinstall the wrist cover and tighten the four screws.
3. Turn the Robot's power ON.
4. Turn the Controller's power ON.

ROBOT BASEBOARD REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the baseboard in the Zymate I and II Robot.

PARTS REQUIRED:

Baseboard: P/N 37335 or 36154 for Zymate I Robots
P/N 38730 for Zymate II Robots

TOOLS REQUIRED:

Screwdriver, flatblade, 1/4"

OPTIONAL:

Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

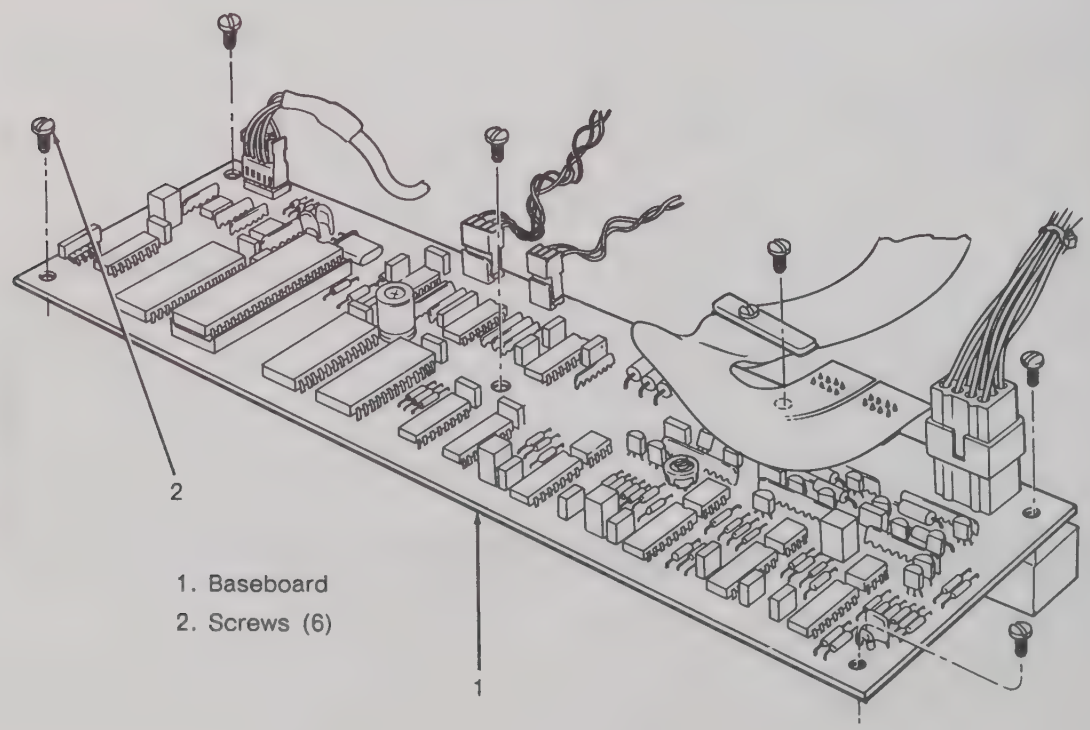
PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Move the arm vertically to mid-height.
   a. Install a post clamp (or other means of support) to hold the arm housing in this position.
4. Remove both skirts.

B. REMOVE THE BASEBOARD

1. Carefully turn the arm to the 90 or 270 degree position.
2. Disconnect the five cables and the flex circuit from the board.
3. Using a small flatblade screwdriver, remove the six screws securing the board.
4. Remove the baseboard by lifting straight up and then forward.



1. Baseboard
2. Screws (6)

PROCEDURE 2: INSTALLATION

A. REPLACE THE BASEBOARD

1. Reconnect all cables with the exception of the flex circuit.

   Make sure that the communication cable (at connector P2) is connected with its green wire to the left.

2. Install the baseboard.
3. Secure the baseboard with the six screws.
4. Reattach the flex circuit, being careful to properly align the connectors with the pins.

B. FINALLY

1. Reinstall the skirts.

> *Note: All benchtop positions must be checked and/or adjusted once new baseboard has been installed.*

ZYMATE I ROBOT
POWER SUPPLY ADJUSTMENTS

PROCEDURE SCOPE:

This service procedure checks and adjusts the seven power supply voltages in the Zymate I Robot Module. This procedure does not pertain to Zymate I Robots built after 8/1/85 with fixed voltage power supplies.

PARTS REQUIRED:

None

TOOLS REQUIRED:

Screwdriver, blade, 1/4"
Digital Voltmeter (DVM)
Screwdriver, precision flatblade, 1.2 mm

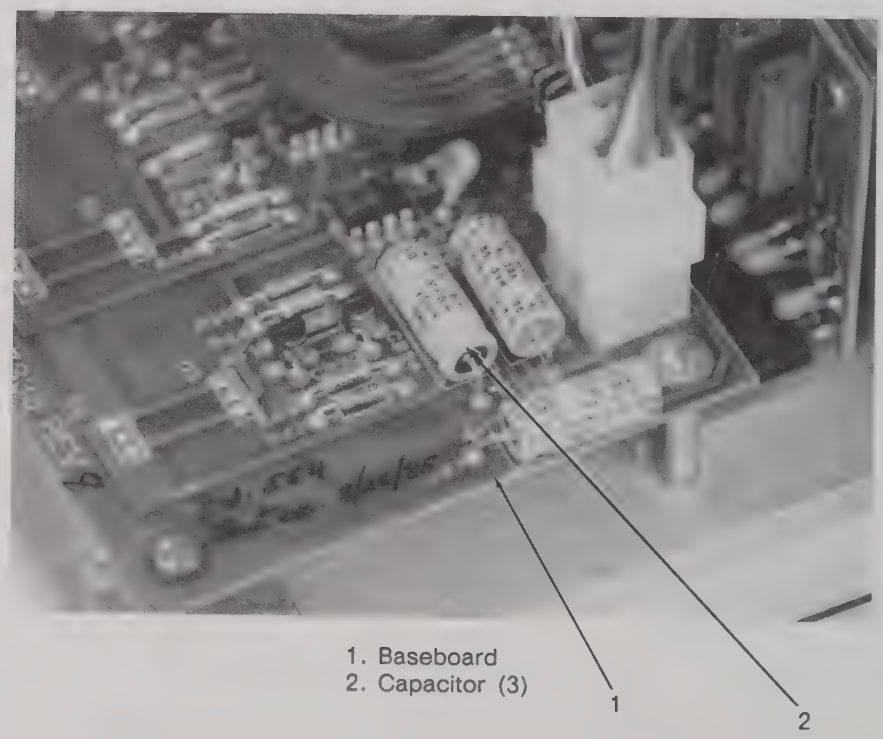
PROCEDURE 1: BASEBOARD POWER SUPPLY VOLTAGES

A. POSITION THE ROBOT

1. Remove both skirts.
2. Turn the arm to either the 0 or 180 degree position.
3. Attach the common lead of the DVM to the baseplate.

   One of the base cover mounting brackets is a convenient tie point.
4. Set the DVM to: Volts, DC, 20V scale.

   The power supply voltages are measured at capacitors C29, C30 and C31, located in the right rear corner of the baseboard.



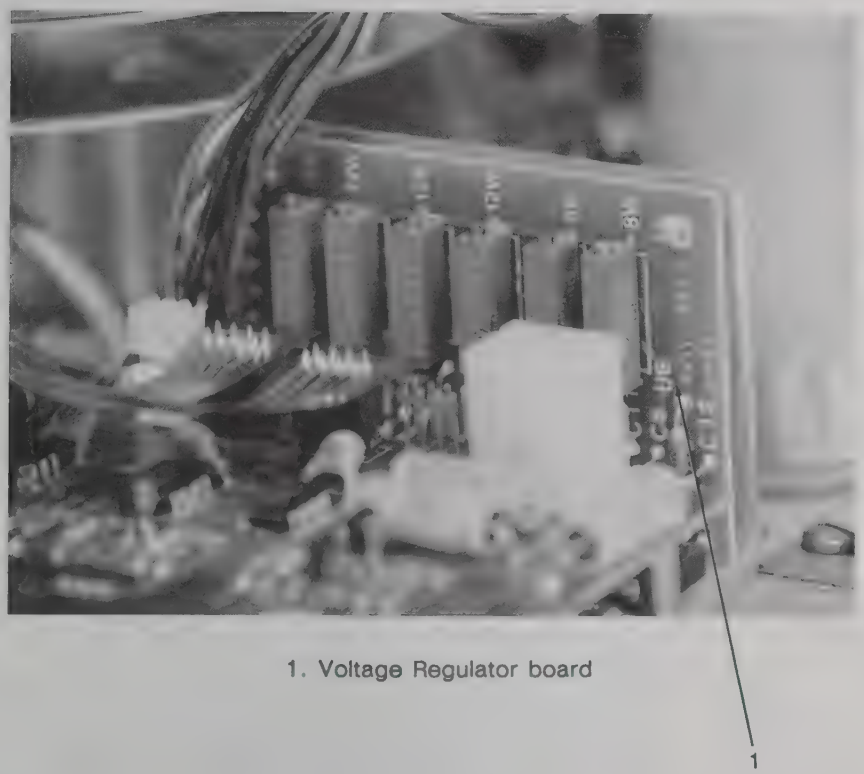
1. Baseboard
2. Capacitor (3)

B. +12B

1. Connect the DVM voltage lead to the (+) end of C31.
2. Check for a voltage reading of +13.6 ± 0.1 volt.
3. Using a small screwdriver, adjust the pot marked +12B on the voltage regulator board until the voltage reads +13.6 ± 0.1 volts.

C. -12B

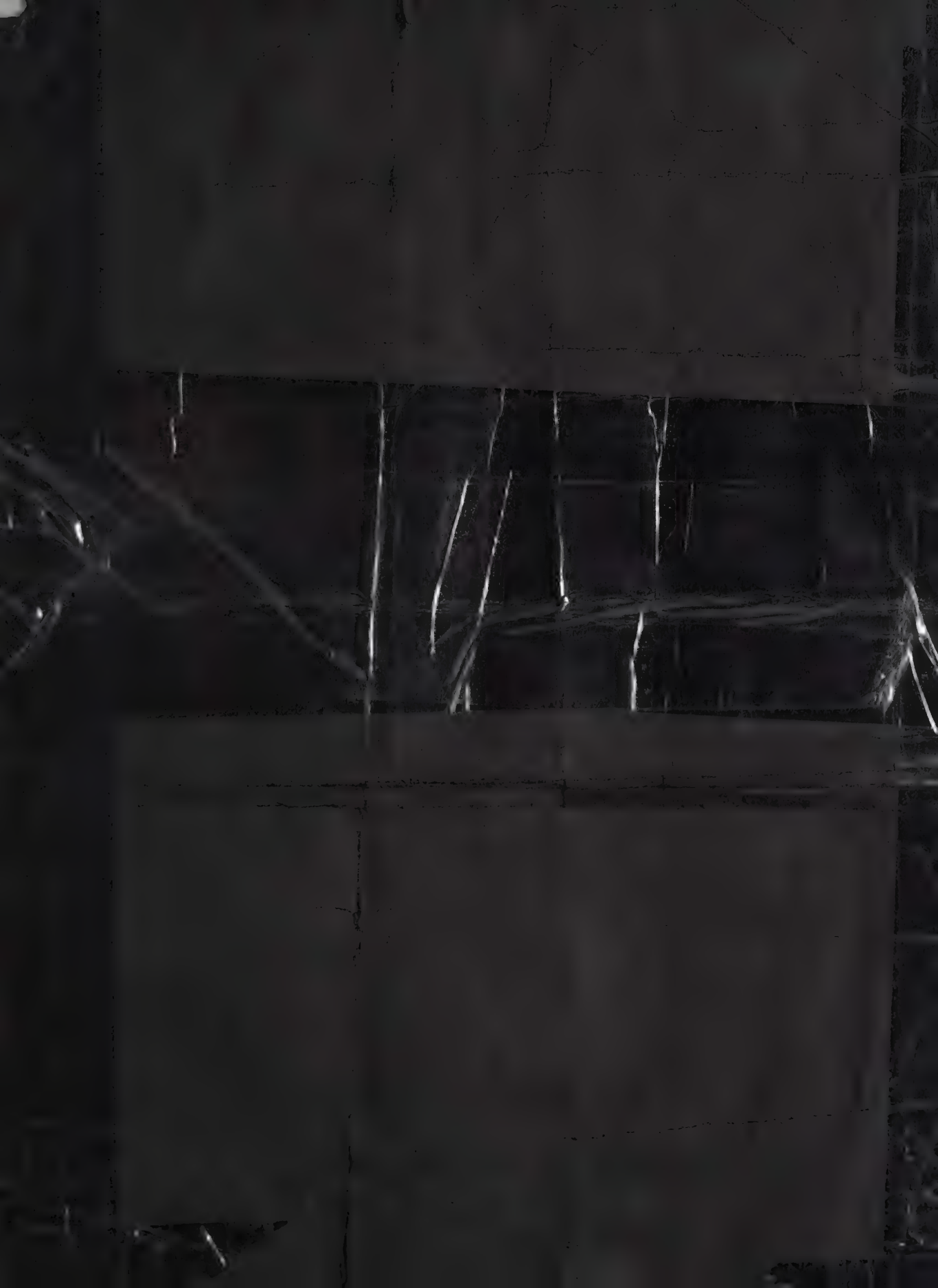
1. Connect the DVM voltage lead to the (-) end of C30.
2. Check for a voltage reading of -13.6 ± 0.1 volt.
3. Using a small screwdriver, adjust the pot marked -12B on the voltage regulator board until the voltage reads -13.6 ± 0.1 volts.

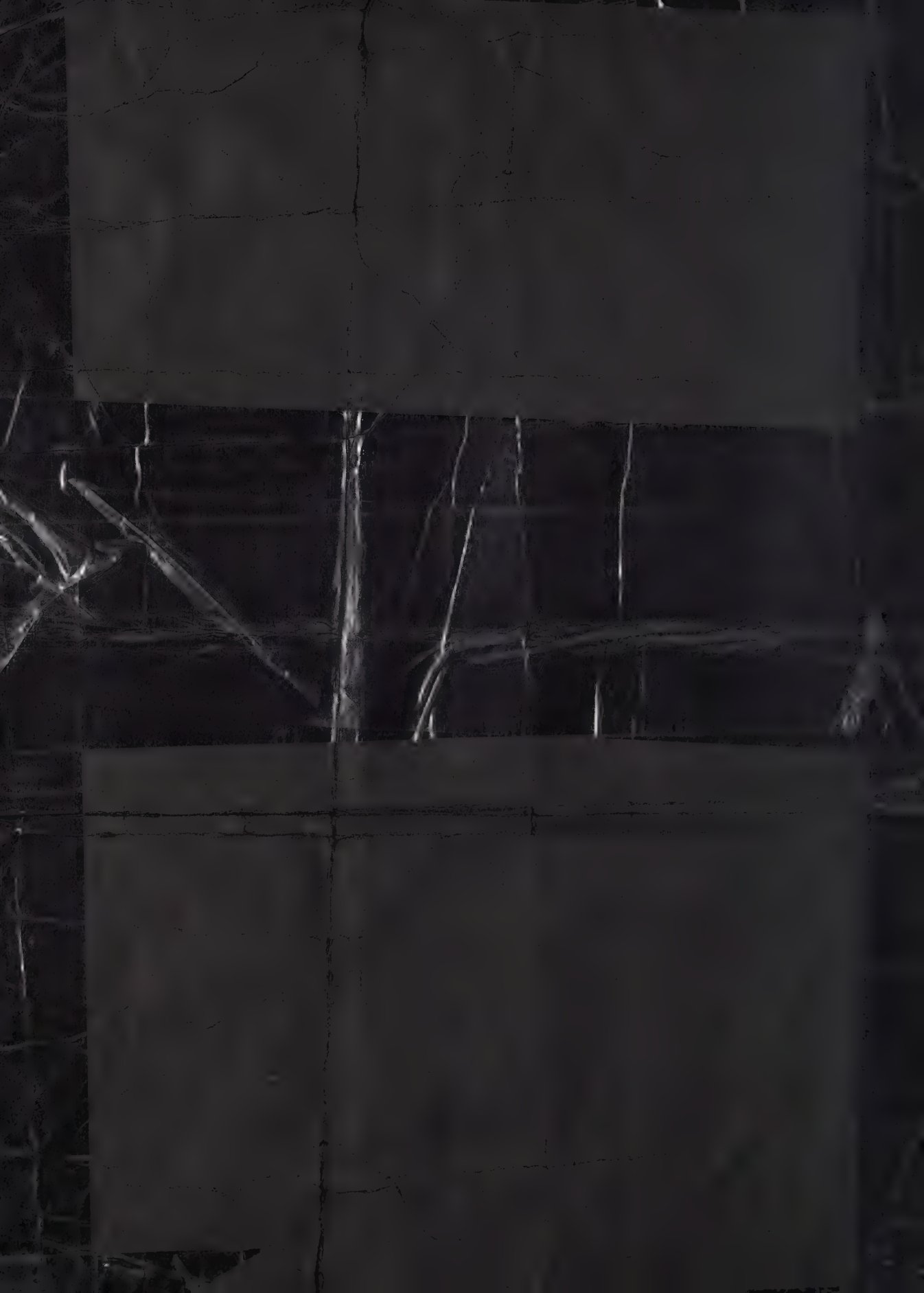


1. Voltage Regulator board

D. +5B

1. Connect the DVM voltage lead to the (+) end of C29.
2. Check for a voltage reading of +5.0 ± 0.1 volt.
3. Using a small screwdriver, adjust the pot marked +5B on the voltage regulator board until the voltage reads +5.0 ± 0.1 volts.



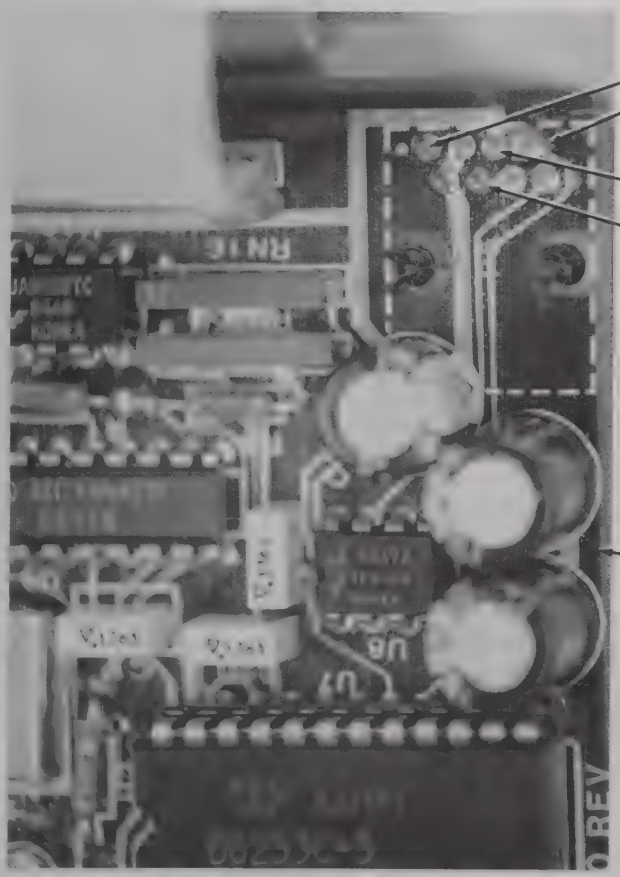


PROCEDURE 2: WRIST BOARD POWER SUPPLY VOLTAGES

A. POSITION THE WRIST

1. Remove the hand from the wrist.
2. Loosen (two turns) the four screws that secure the cover to the wrist box.
3. Lift the cover and carefully "hinge" it back onto the arm.
4. Unplug the wrist motor leads from the wrist board before checking or setting voltages.
5. Connect the common lead to wrist circuit ground

   A convenient ground point is the LEFT end of the 2.2 ohm resistor (red-red-gold-gold) on the wrist board.



1. Connector P5
2. Pin 1
3. Pin 4
4. Pin 5
5. Wrist board

B. +12W

1. Connect the DVM voltage lead to Pin 1 of connector P5.
2. Check for a voltage reading of +13.6 ± 0.1 volt.
3. Using a small screwdriver, adjust the pot marked +12W on the voltage regulator board until the voltage reads +13.6 ± 0.1 volts.

C. −12W

1. Connect the DVM voltage lead to Pin 4 of connector P5.
2. Check for a voltage reading of −13.6 ± 0.1 volt.
3. Using a small screwdriver, adjust the pot marked −12W on the voltage regulator board until the voltage reads −13.6 ± 0.1 volts.

D. +8W

1. Connect the DVM voltage lead to Pin 5 of connector P5.
2. Check for a voltage reading of +8.0 ± 0.1 volt.
3. Using a small screwdriver, adjust the pot marked +8W on the voltage regulator board until the voltage reads +8.0 ± 0.1 volts.

E. FINALLY

1. Reconnect the wrist motor leads.
2. Replace the wrist cover and secure with the four screws.
3. Replace the Robot skirts and secure with the seven screws.

ROTARY POTENTIOMETER REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the precision potentiometer which determines the rotary position of the Zymate Robot.

PARTS REQUIRED:

Rotary potentiometer, P/N 36816
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, blade, 1/4"
Wrench, hex .050 (Allen)
Wire cutters
Digital voltmeter (DVM)

OPTIONAL:

Square, 12" (or larger)

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF.
3. Manually turn the Robot's arm COUNTER-CLOCKWISE to the zero degree position.

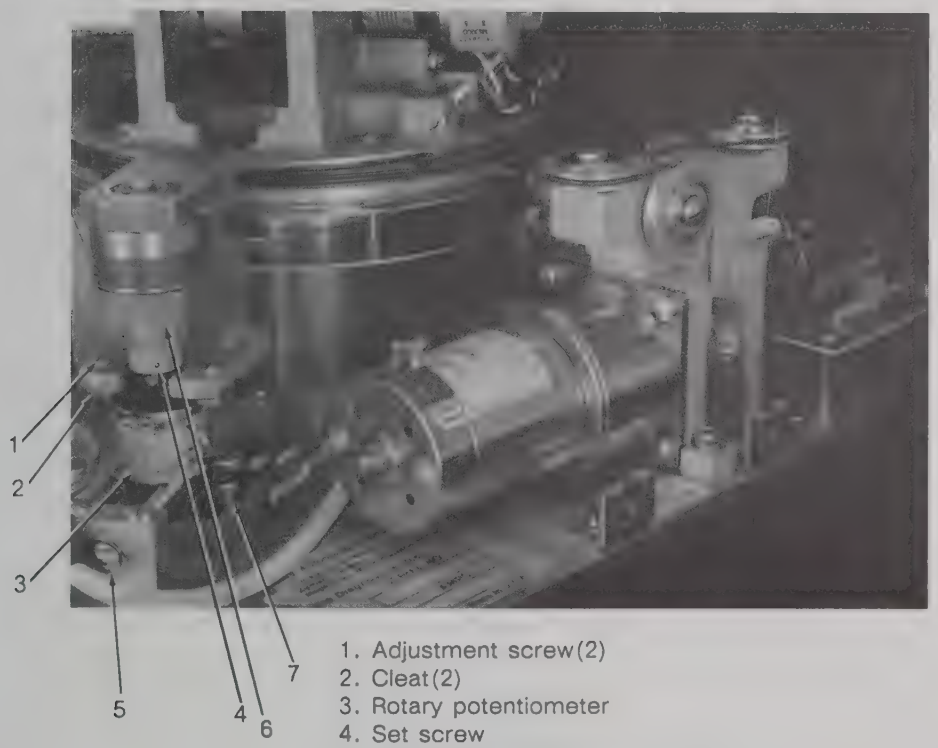
   This position will have the wrist centered above the power cord connection.
4. Push the wrist fully IN.
5. Remove both skirts.

B. UNFASTEN THE POT

1. Locate the rotary position pot and its flexible shaft coupling.
2. Loosen the coupling's LOWER set screw one turn.

   Turn the Robot's arm SLIGHTLY if required to access the set screw.

3. Loosen both pot adjusting screws so that the cleats can be turned with the flat FACING THE POT and retighten the screws.



1. Adjustment screw(2)
2. Cleat(2)
3. Rotary potentiometer
4. Set screw
5. Servo cable adjustment screw
6. Rotary pot assembly
7. Allen head(2)

C. REMOVE THE POT

1. Draw the pot DOWNWARD.
2. Slide it out of the bracket.
3. Carefully snip the cable tie with wire cutters.
4. Unplug the pot from the Robot baseboard.
5. Unplug the rotary motor leads.

PROCEDURE 2: INSTALLATION

A. CONNECT THE POT

1. Plug the new pot into the baseboard.
2. Dress the pot leads near the cable tie point and back beside the rotary motor.

B. SET THE POT

1. Connect a digital voltmeter (DVM).
   a. "+" lead to pot wiper (black wire)
   b. "–" lead to CCW pot terminal (red wire)
2. Set the DVM to: Volts, DC, 2V scale.
3. Position the pot with its terminals clear of other objects so its shaft can be easily turned.

> *Note: Do not slide the pot into its flexible coupling at this time.*

4. Turn ONLY the Robot's power ON.

> *Note: Make sure that the Robot's arm is still in the zero degree position.*

5. Turn the pot shaft until the DVM reads 0.41 volts.
6. Turn the Robot's power OFF.
7. Disconnect the DVM.

C. FASTEN THE POT

1. Position the pot body with the leads facing OUTWARD from the Robot.
2. Being CAREFUL to avoid turning the pot shaft, slide the pot under its coupling and lift it vertically upward into position. (Refer to the photo on page 3 for positioning details).
3. Loosen both adjusting screws and turn the cleats to engage the flange at the top of the pot body.
4. Tighten both adjusting screws until JUST snug.

5. Tighten the coupling LOWER set screw.
6. Install a new cable tie.
7. Check that the pot leads are well clear of moving parts.
8. Plug the motor leads into the Robot baseboard.

PROCEDURE 3: POSITION ADJUSTMENT

Loosening the adjusting screws and cleats will permit the pot body to be turned, changing the Robot's rotary position. This adjustment may be used to:

- Set the arm position at zero rotary angle; or,
- Reset the arm to a previously named location to minimize the need for reprogramming after a pot change.

A. ZERO ADJUSTMENT

1. Turn the Robot and Controller's power ON.
   a. Wait for the system to initialize.
2. Use the Robot's teaching screen to move Robot to the ZERO rotary angle position.
3. Loosen the adjusting screws until a slight amount of resistance is felt when FINGER TURNING the pot body.
4. Align the arm to be perpendicular with the front or rear edge of the baseplate.

   A square placed against the baseplate is a handy sighting aid.
5. Retighten the adjusting screws until JUST snug.

B. NAMED LOCATION ADJUSTMENT

1. Turn the Zymate System's power ON.
   a. Wait for system to initialize.
2. Use the Robot's teaching screen to move the Robot to a NAMED location.

   This location will typically be a critical position near the center of the bench set-up.
3. Loosen the adjusting screws just enough so the pot body can be FINGER TURNED.
4. Align the arm to the desired location.
5. Retighten the adjusting screws unjtil JUST snug.

C. FINALLY

1. Turn the Zymate System's power OFF.
2. Reinstall the Robot skirts.

VERTICAL CABLE REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the vertical cable for the Zymate Robot.

PARTS REQUIRED:

Cable, Vertical (long), P/N 36079
Cable, Vertical (short), P/N 36078

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8", 1/4", 5/32"
Screwdriver, holding
Screwdriver, Phillips, #1
Screwdriver, ball-end hex, 9/64
Wrench, Allen, 3/32
Masking tape
Loctite 222®
Light hammer
Flashlight or penlight

OPTIONAL:

Robot post clamp, P/N 38236

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PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

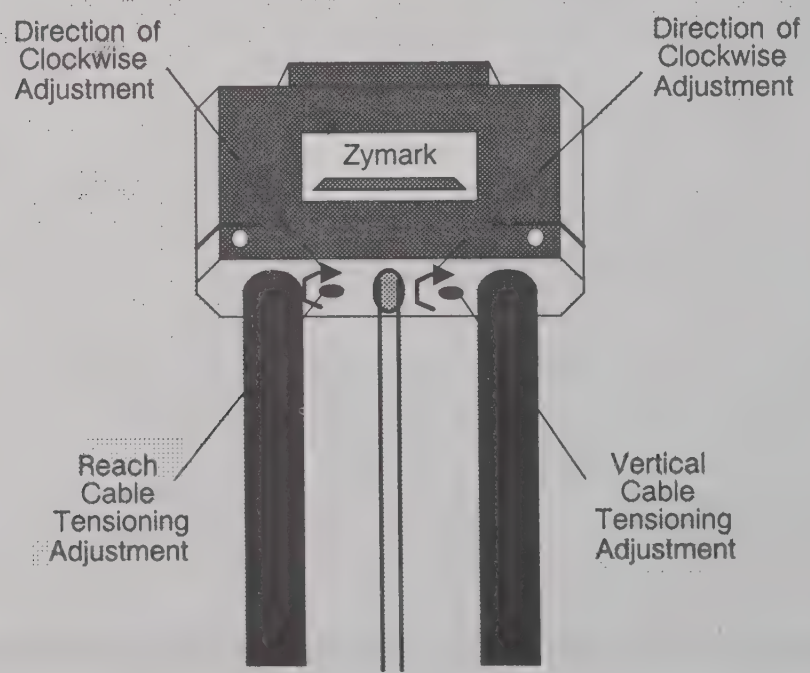
1. Turn the Controller's power OFF.
2. Turn the Robot's power OFF and disconnect the power cord.
3. Move the arm vertically to mid-height. Install a post clamp (or other means of support) to hold the arm housing in position.
4. Pull the arm out half way.

B. RELAX CABLE TENSION

1. Using the 9/64 ball-end driver, turn the vertical drive cable adjustment fully CLOCKWISE.

   See the diagram below for adjustment location.

2. Remove the cover on the top of the column cap assembly.
3. Turn the compression screw next to the vertical cable pulley fully CLOCKWISE to relax cable tension.

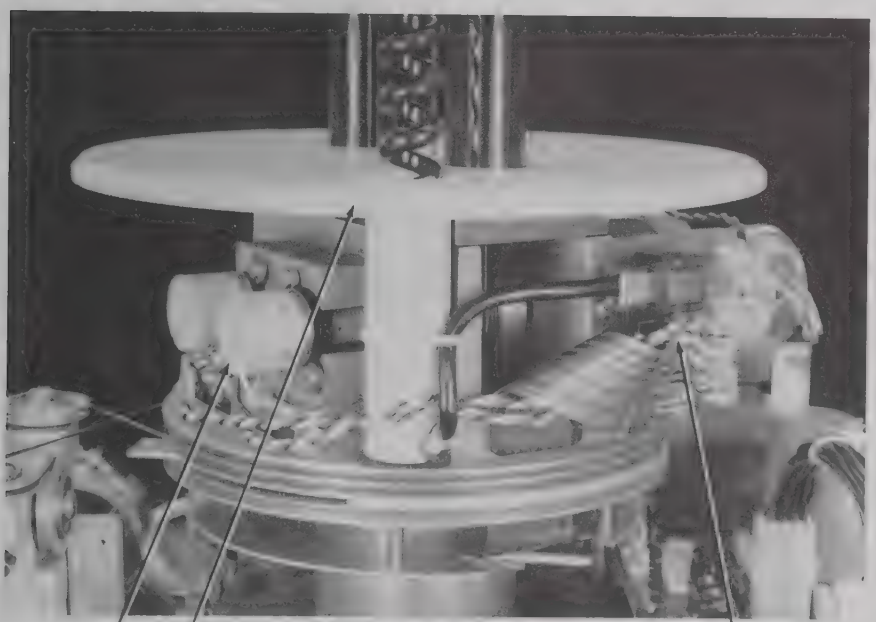


C. DISASSEMBLY

1. Remove both Robot skirts.
2. Unplug the connections from the interconnection board. Use a small screwdriver to push against the clip on the backside of the coil cord and unplug the cord.
3. Remove the turntable cover half that contains the coil cord tube.

> *Note: Avoid twisting or uncoiling of the cord during handling. GAINING or LOSING turns will change the effective cord length.*

4. Tape the turntable cover termporarily to the arm housing.
5. Using a Phillips screwdriver, remove the coil cord support from the arm housing.
6. Tape the coil cord support with attached coil cord to the wrist.



1. Vertical potentiometer
2. Turntable cover with coil cord tube
3. Interconnection board

D. ACCESS THE DRIVE DRUM

1. Remove the interconnection board from the turntable.
2. Remove the second half of the turntable cover.
3. Remove the vertical potentiometer and flex coupling:

   Raise the arm housing slightly to gain access to the set screws in the drive drum.

   a. Remove the set screw on the pot side of the drum by tapping the Allen wrench into the screw with the hammer. This insures that the wrench is fully seated within the screw. Since the set screws are held in place with Loctite 222®, it may be necessary to grasp the Allen wrench with two hands to generate enough force to loosen the screw.

   b. Loosen the two screws that hold the cleats in place and turn the cleats so their flats face the pot.

   c. Remove the pot/coupling assembly.

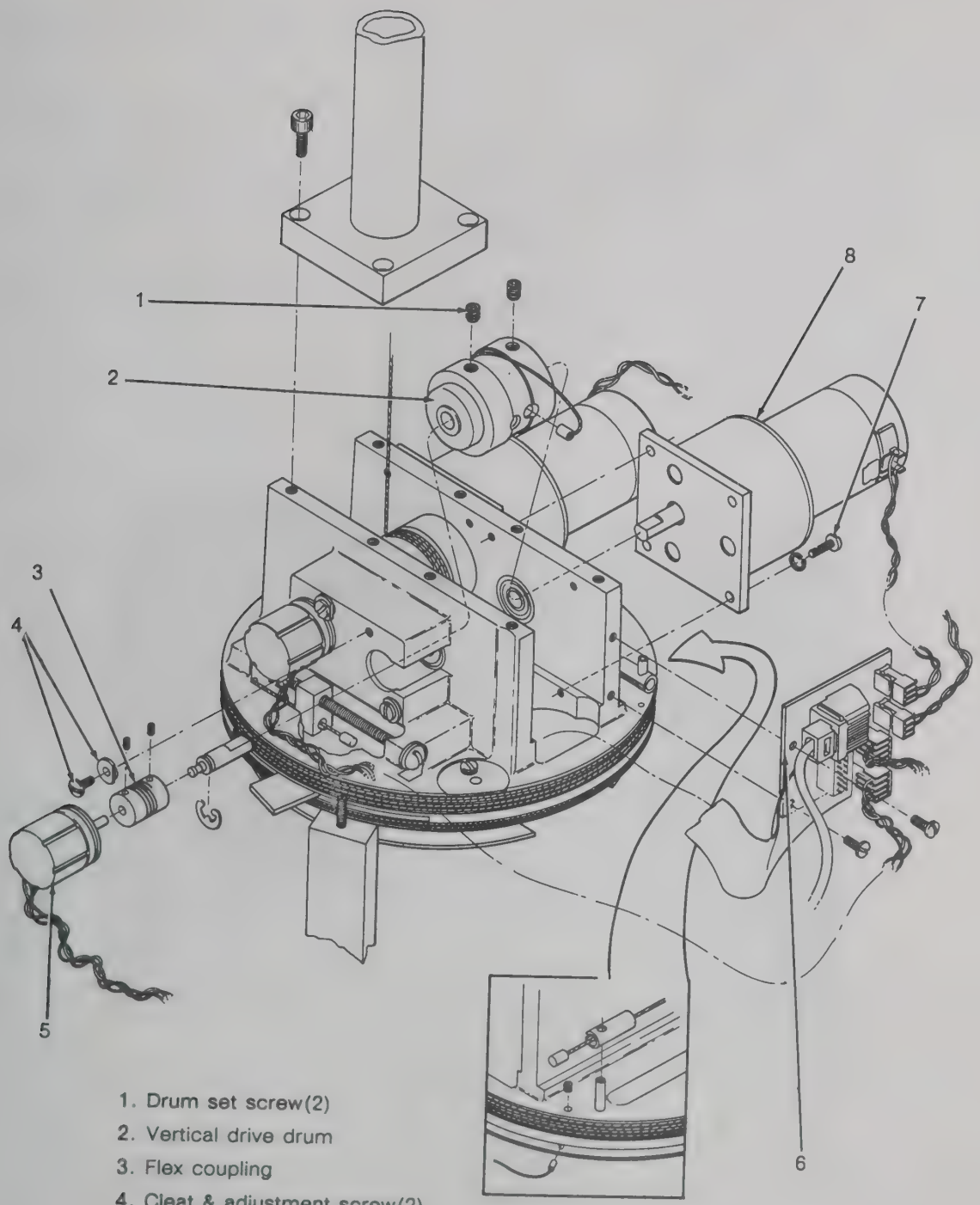
4. Remove the vertical motor.

   With the set screws in the drum facing outward:

   a. Using the hammer as in step 3a, remove the set screw on the motor side of the drum.

   b. Remove the four motor mounting screws and lockwashers.

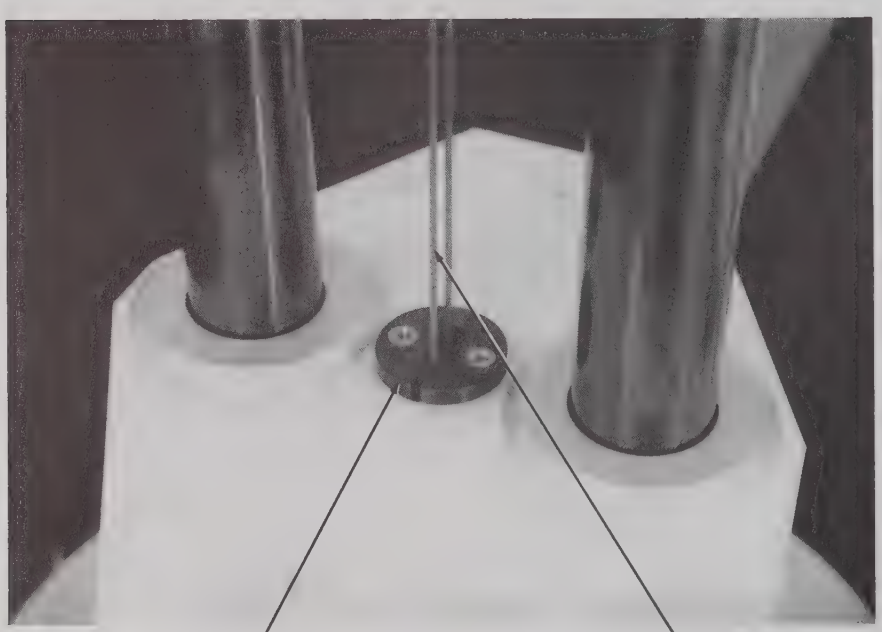
   c. Slide the motor out of position and set aside.



1. Drum set screw(2)
2. Vertical drive drum
3. Flex coupling
4. Cleat & adjustment screw(2)
5. Vertical potentiometer
6. Interconnection board
7. Motor screw & lockwasher(4)
8. Vertical motor

E. REMOVE THE CABLES

1. Using a Phillips screwdriver, remove the black cable retainers from the center of the top and bottom arm housing surfaces.
2. Remove the cable ends attached to the retainers and set the retainers and screws aside.
3. After pulling the long vertical cable through the column cap assembly and down the column, remove the drum from the turntable housing.
4. Unwrap both cables from the drum.

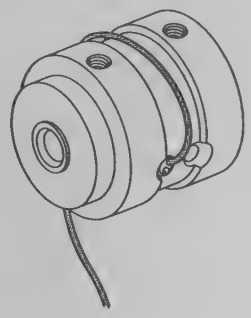


1. Cable retainer(2)
2. Vertical cable

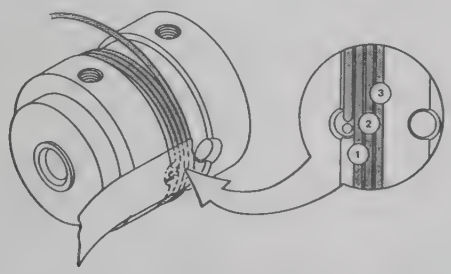
PROCEDURE 2: INSTALLATION

A. WRAP THE CABLES

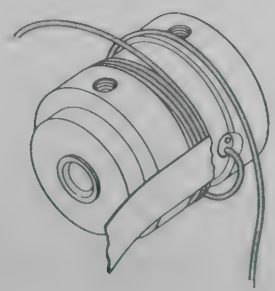
1. Prepare two pieces of tape 1 1/8 inches long.
2. Holding the vertical drum with the shoulder to the left, insert the ferrule of the new, long cable into the left hole of the drum.



3. Wrap the cable UP and OVER the drum for 3 turns. Use the ferrule hole as the reference point.
4. Secure the cable in place by using one of the pieces of tape. Be sure not to cover the right section of the drum with the tape.

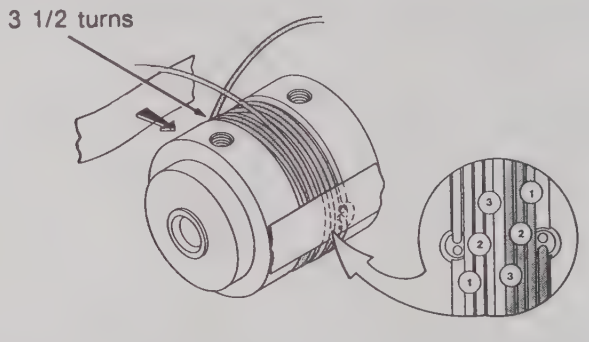


5. Insert the ferrule of the new, short cable into the right hole of the drum.
6. Wrap the cable DOWN and UNDER the drum for 3 1/2 turns, again using the ferrule hole as a reference point.



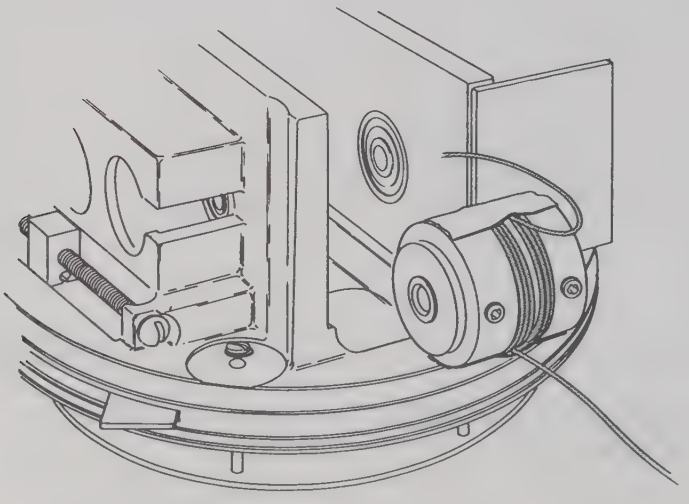
7. Secure the short cable by placing the second piece of tape perpendicular to the direction of the cable wraps, directly across the two ferrule holes. Do NOT extend the tape onto the flat ends of the drum.

8. Carefully remove the first piece of tape (see step 4) and reposition it so that it runs parallel to the second piece. Make sure it is positioned 180 degrees opposite the second piece of tape.



B. REINSTALL THE DRUM

1. Insert the drum into position within the turntable housing. Position the drum so that the set screw holes face outward and the shoulder is to the left.



2. Insert the pot/coupling assembly into the left end of the drum with the shaft flat facing outward.

3. Slide the motor into position with the flat facing outward and secure it in place with the four screws and lockwashers.

4. Center the drum within the housing and use the flashlight to sight through the set screw holes to verify that both shaft flats face outward.

5. Apply a drop of Loctite 222® to the threads of one of the set screws and insert it into the hole on the motor side of the drum. Tighten until snug.

6. Verify that the set screw is aligned with the shaft flat on the motor by doing the following:

   a. Loosen the set screw 1/8 to 1/4 turn. (Keep the Allen wrench in position on the set screw).

   b. Place a finger on the tail shaft protruding from the right end of the motor.

   c. Using the Allen wrench as a lever, rotate the drum back and forth (approximately 10 degrees) in each direction. If properly aligned, contact made between the set screw and the shaft flat (as the drum is rotated) will stop the drum from rotating more than 10 degrees or so in each direction. Also, the tail shaft of the motor will move slightly each time contact is made.

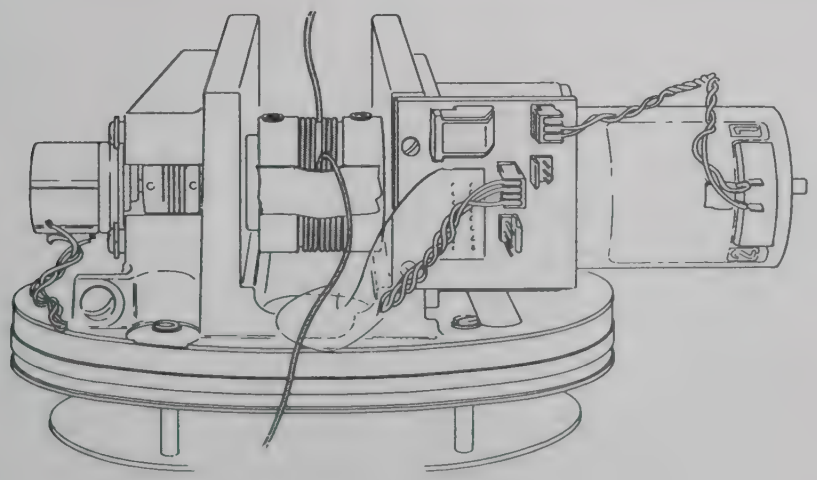
   d. Continue to slowly rotate the drum while simultaneously tightening down on the set screw. This insures that the set screw is centered on the flat. Tighten securely.

   e. If the tail shaft did not move and contact was not made, remove the set screw and motor and repeat steps 3–6.

7. After applying Loctite® to the second set screw, insert it into the left side of the drum. Make sure the pot/coupling assembly is pushed fully into the drum. Securely tighten the set screw against the flat.

8. Locate the tail shaft as it protrudes from the back of the vertical motor.

9. Turn the shaft CLOCKWISE until the two set screws in the drum face UP.



10. Carefully pull the short vertical cable up through the opening between the two columns.

C. ATTACH THE LONG CABLE

1. Take the long vertical cable and push it up through the column until it reaches the top.
2. Run the cable over the pulley and down through the hole in the bottom of the column cap assembly.
3. Securely tape the cable in place on the pulley.
4. With the slot opening toward the wrist, slide a cable retainer over the reach cable that extends into the top of the arm housing so that the reach cable runs through the hole in the cable retainer.
5. Slide the long vertical cable through the slot and insert the ferrule into the cutout on the underside of the cable retainer.
6. Secure the retainer and attached vertical cable to the top of the arm housing with the two Phillips screws previously removed.

> *Note: It may be necessary to move the arm housing up slightly to allow the retainer to be secured.*

7. Remove any vertical cable slack from above the arm housing by carefully lowering the arm housing until the slack is just removed. Resecure the arm housing.

D. ATTACH THE SHORT CABLE

1. With the slot opening away from the wrist, slide the cable retainer over the reach cable that extends into the bottom of the arm housing so that the reach cable runs through the hole in the cable retainer.
2. Slide the short vertical cable through the slot and insert the ferrule into the cutout on the topside of the cable retainer.
3. Secure the cable retainer and attached vertical cable to the bottom of the arm housing with the two Phillips screws previously removed.
4. Loosen the compression screw in the column cap assembly until the top of the screw is even with the top of the column cap body.

E. TENSION THE CABLES

1. Remove the tape from the drum and the pulley.
2. Remove the arm housing support and let the arm housing settle to the bottom limits of its travel.
3. Turn the vertical drive tensioning adjustment (located on the underside of the column cap assembly) COUNTER-CLOCKWISE until a slight resistance is felt. This resistance is the first contact between the adjusting screw and the cable-tensioning device within the column cap assembly.
4. Continue to turn the adjustment COUNTER-CLOCKWISE one more turn. If correctly adjusted, a force of approximately 2 lbs. should move the center of the cable .20 to .25 inch (.5 to .6 cm).

PROCEDURE 3: REASSEMBLE THE ROBOT

A. REPLACE THE COIL CORD

1. Reattach the coil cord support to the arm housing with the long Phillips screws previously removed.
2. Reinstall the interconnection board.
3. Reinstall the two turntable covers.
4. Reconnect the cables to the interconnection board.

B. SET VERTICAL ZERO

1. Refer to R55, PROCEDURE 3 to reset the vertical zero for the Robot.

> *Note: This procedure is critical to optimizing Robot performance.*

REACH CABLE REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the reach drive cables for the Zymate Robot.

PARTS REQUIRED:

Cable, reach (long), P/N 36082
Cable, reach (short), P/N 36081

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8", 1/4", 5/32"
Screwdriver, holding
Screwdriver, phillips #1
Screwdriver, ball-end hex, 9/64
Wrench, allen, .050, 3/32
Masking tape
Loctite 222®
Light hammer
Flashlight or penlight

OPTIONAL:

Robot post clamp, P/N 38236

Note: FOR PY ROBOTS ONLY – Performing the following service procedure, or any procedure requiring the adjustment or replacement of certain Robot components (i.e. pots, bearings, baseboard, cables, etc.), CHANGES Py Robot positioning and REQUIRES that NEW CALIBRATION FACTORS be entered. Refer to the Py Robot Calibration Procedure in the Robot section of the Service Manual to update your Py Robot calibration. Call Zymark Service if you have any questions concerning your Py Robot's service or calibration.

PROCEDURE 1: DISASSEMBLY

A. POSITION THE ROBOT

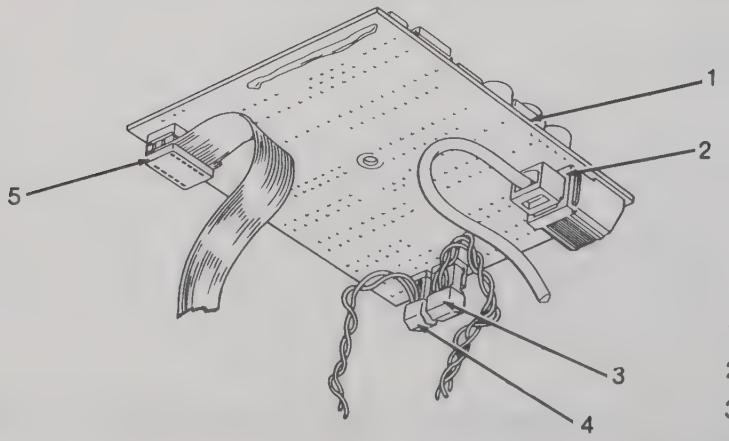
1. Turn the Controller's power OFF.
2. Turn the Robot' power OFF and disconnect the power cord.
3. Move the arm vertically to mid-height. Install a post clamp (or other means of support) to hold the arm in position.
4. Pull the arm out half way.

B. REMOVE THE COIL CORD FROM THE WRIST

1. Loosen (two turns) the four screws that secure the wrist cover.
2. Lift the wrist cover and carefully "hinge" it over onto the arm.
3. Remove the center screw from the wrist electronics board.
4. Carefully lift the board from the wrist box to allow access to the 4 connectors on the bottom side of the board.
5. Unplug the potentiometer and motor leads.
6. Using a small flatblade screwdriver, carefully pry the multi-colored ribbon cable connector from its socket.

*** * * WARNING * * ***

Do NOT use your fingers to remove the ribbon cable connector from its socket. Connector legs are very sharp and easily damaged.

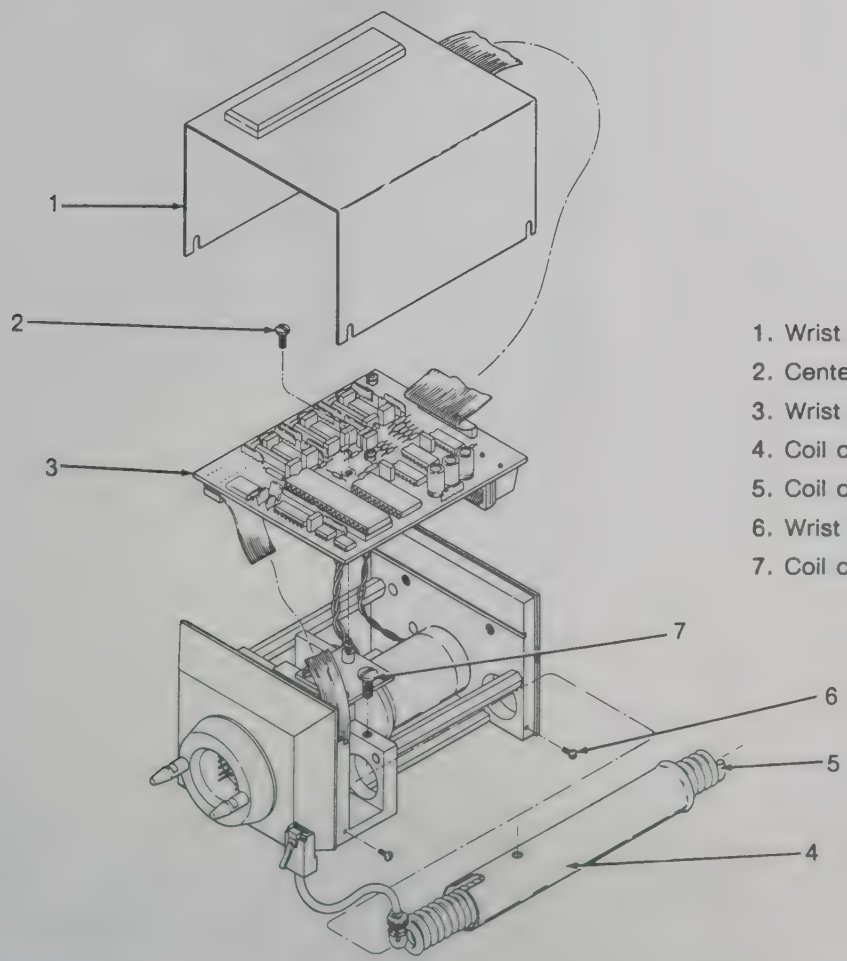


1. Wrist electronics board
2. Coil cord connector
3. Wrist potentiometer leads
4. Wrist motor leads
5. Ribbon cable connector

7. Using the same screwdriver, push against the clip at the top of the coil cord connector and unplug the cord.
8. Maintaining the ribbon cable connection between the wrist electronics board and the wrist cover board, carefully remove the assembly and set aside.
9. Loosen the coil cord tube fastening screw.
10. Remove the coil cord tube from the wrist box:
    a. Pull the rubber grommet and coil cord out of the notch in the tube.
    b. Allow the cord to retract into the tube and slide the tube out of the wrist box.

> *Note: Avoid twisting or uncoiling of the cord during handling. GAINING or LOSING turns will change the effective cord length.*

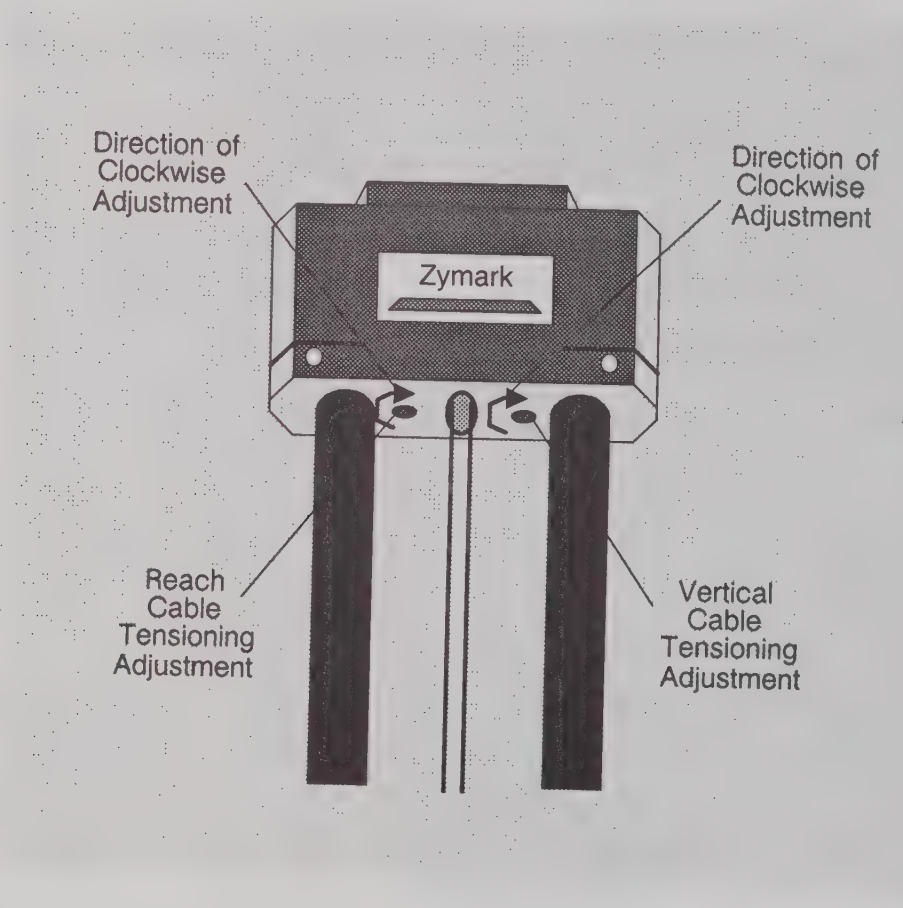
11. Resecure the rubber grommet and coil cord back into the notch in the tube.
12. Tape the coil cord and tube to the arm housing.



1. Wrist cover
2. Center screw
3. Wrist electronics board
4. Coil cord tube
5. Coil cord
6. Wrist cover screw(4)
7. Coil cord tube fastener

C. RELAX CABLE TENSION

1. Using the 9/64 ball-end driver, turn the reach drive cable tensioning adjustment fully CLOCKWISE.
2. Remove the cover on the top of the column cap assembly.
3. Turn the compression screw next to the reach cable pulley fully CLOCKWISE to relax cable tension.

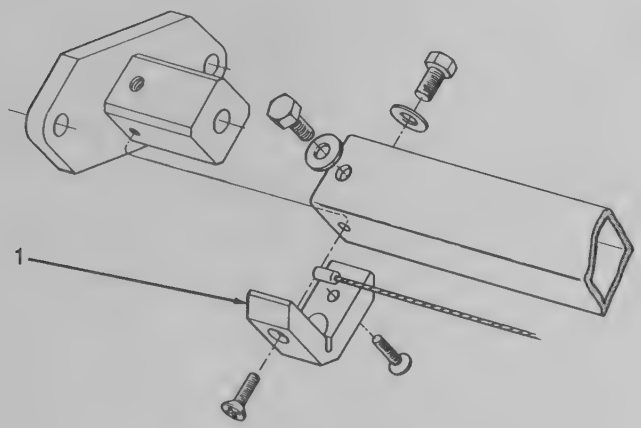


D. DISCONNECT CABLE ENDS

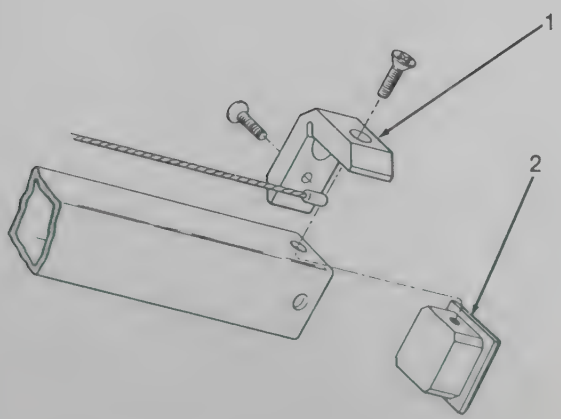
1. Using a phillips screwdiver, remove the black V-shaped cable retainer at each end of the arm.
2. Remove the black plug at the rear of the arm.
3. Tape the loose cable ends temporarily to the arm housing.

E. REMOVE THE ARM

1. Loosen (clockwise) both arm bearing adjustment screws approximately 1 to 1 1/2 turns.
2. Slide the arm completely out of the arm housing.



1. Cable retainer



1. Plug
2. Cable retainer

F. DISASSEMBLY

1. Remove both Robot skirts.
2. Unplug the connectors from the interconnection board.
3. Use a small screwdriver to push against the clip at the rear of the coil cord connector to unplug the cord.
4. Remove the turntable cover half that contains the coil cord tube.

> *Note: Avoid twisting or uncoiling of the cord during handling. GAINING or LOSING turns will change the effective cord length.*

5. Tape the turntable cover temporarily to the arm housing.
6. Using a phillips screwdriver, remove the coil cord support from the arm housing.
7. Place the coil cord/coil support assembly aside.

G. ACCESS THE DRIVE DRUM

1. Remove the remaining half of the turntable cover.
2. Remove the reach potentiometer and flex coupling:

   Turn the drum slightly if required to access the set screws in the drum.

   a. Remove the set screw on the pot side of the drum by tapping the Allen wrench into the screw with the hammer. This insures that the wrench is fully seated within the screw. Since the set screws are held in place with Loctite 222®, it may be necessary to grasp the Allen wrench with two hands to generate enough force to loosen the screw.

   b. Loosen the screws that hold the cleats in place and turn the cleats so their flats face the pot.

   c. Remove the pot/coupling assembly.

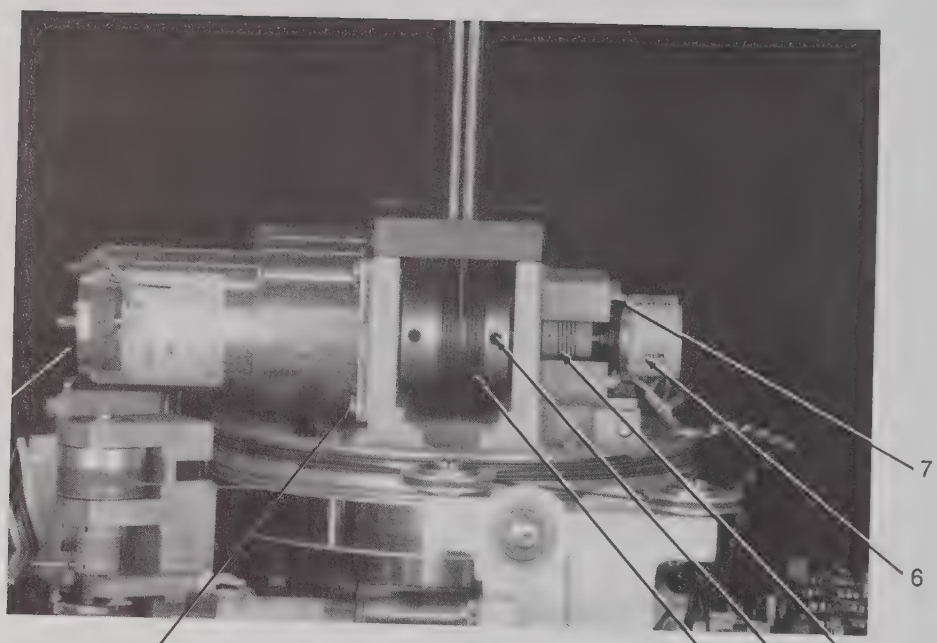
3. Remove the reach motor.

   With the set screws in the drum facing outward:

   a. Using the hammer as described in step 2a, remove the set screw on the motor side of the drum.

   b. Remove the four motor mounting screws and lockwashers.

   c. Slide the motor out of position and set aside.



1. Reach motor
2. Motor mounting screw and lockwasher (4)
3. Reach drum
4. Set screw (2)
5. Flex coupling
6. Reach potentiometer
7. Cleat and adjustment screw (2)

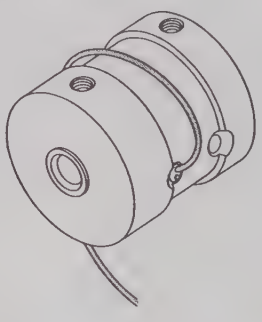
H. REMOVE CABLES

1. Remove the tape securing the cable ends to the arm housing.
2. Carefully pull the reach cable that exits the top of the arm housing through the hole in the upper cable retainer, over the pulley in the column cap and down through the arm itself.
3. Pull the reach cable that exits the bottom of the arm housing through the hole in the lower retainer.
4. Remove the drum from the turntable housing.
5. Unwrap the cables from the drum.

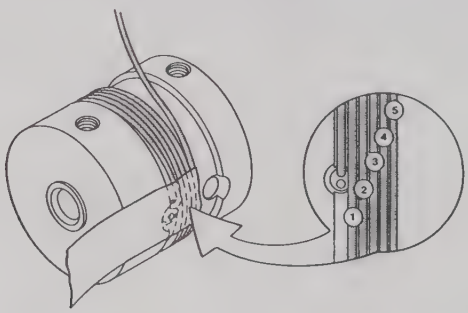
PROCEDURE 2: INSTALLATION

A. WRAP THE CABLES

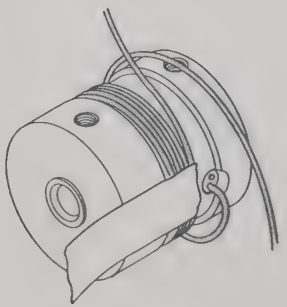
1. Prepare two pieces of tape 1 1/8 inches long.
2. Holding the drum with the wider shoulder to the left, insert the ferrule of the new, long cable into the left hole of the drum.



3. Wrap the cable UP and OVER the drum for 5 turns. Use the ferrule hole as a reference point.
4. Secure the cable in place by using one of the pieces of tape. Be sure not to cover the right section of the drum with the tape.

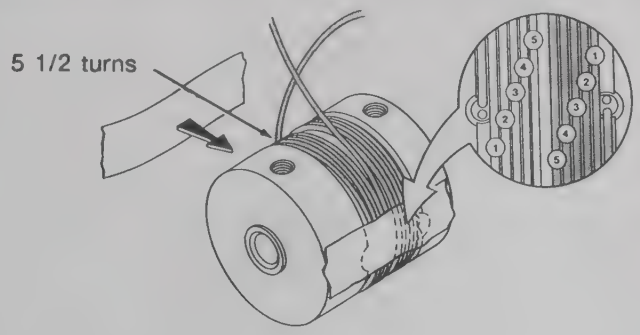


5. Insert the ferrule of the new, short cable into the right hole of the drum.
6. Wrap the cable DOWN and UNDER the drum for 5 1/2 turns, again using the ferrule hole as a reference.



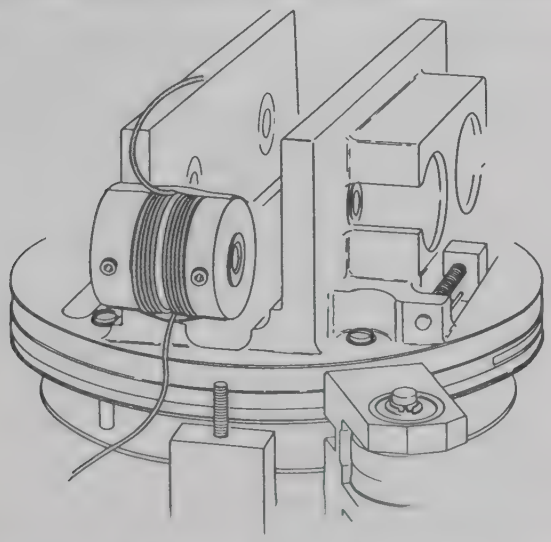
7. Secure the shorter cable by placing the second piece of tape perpendicular to the direction of the cable wraps, directly over the two ferrule holes. Do NOT extend the tape onto the flat ends of the drum.

8. Carefully remove the first piece of tape (see step 4) and reposition it so that it runs parallel to the second piece. Make sure that it is positioned 180 degrees opposite the second piece of tape.



B. REINSTALL THE DRUM

1. Insert the drum into position within the turntable housing. Position the drum so that the set screw holes face outward and the wide shoulder is to the left.



2. Insert the pot/coupling assembly into the right end of the drum with the shaft flat facing outward.

3. Slide the motor into position with the shaft flat facing outward and secure it in place with the four screws and lockwashers.

4. Center the drum within the housing and use the flashlight to sight through the set screw holes to verify that both shaft flats face outward.

5. Apply a drop of Loctite 222® to the threads of one set screw and insert it into the hole on the motor side of the drum. Tighten until snug.

6. Verify that the set screw is aligned with the shaft flat on the motor by doing the following:

   a. Loosen the set screw 1/8 to 1/4 turn. (Keep the Allen wrench in position on the set screw).

   b. Place a finger on the tail shaft protruding from the left end of the motor.

   c. Using the Allen wrench as a lever, rotate the drum back and forth (approximately 10 degrees) in each direction. If properly aligned, contact made between the set screw and the shaft flat (as the drum is rotated) will stop the drum from rotating more than 10 degrees or so in each direction. Also, the tail shaft of the motor will move slightly each time contact is made.

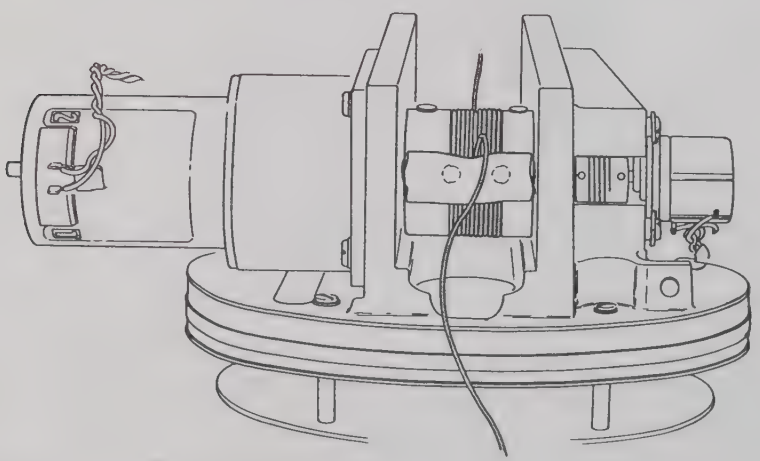
   d. Continue to slowly rotate the drum while simultaneously tightening down on the set screw. This insures that the set screw is centered on the flat. Tighten securely.

   e. If the tail shaft did not move and contact was not made, remove the set screw and motor and repeat steps 3–6.

7. After applying Loctite 222® to the second set screw, insert it into the right side of the drum. Make sure that the pot/coupling assembly is pushed fully into the drum. Securely tighten the screw against the flat.

8. Locate the end of the reach motor tail shaft as it protrudes from the back of the motor.

9. Turn the shaft CLOCKWISE until the two set screws in the drum face UP.



10. Carefully pull the short reach cable up through the opening between the two columns.

11. Turn the two cleats so their flats face away from the pot and tighten the securing screws.

C. ROUTE CABLES INTO ARM HOUSING

1. Take the long reach cable and push it up through the column until it reaches the top.
2. Run the cable over the pulley and down through the hole in the bottom of the column cap assembly.
3. Tape the cable securely in place on the pulley.
4. Insert the ferrule end of the long cable into the hole of the upper cable retainer at the top of the arm housing.
5. Reach in and pull the long cable end out of the rear opening of the arm housing.
6. Sighting through the opening, route the cable over the pulley within the housing. Maintaining a small amount of tension on the cable (to keep it in place on the pulley), tape the cable to the arm housing just above the point where it exits the housing.
7. Take the short reach cable and insert the ferrule into the hole of the lower cable retainer at the bottom of the housing.
8. Pull the short cable end through the front opening of the arm housing.
9. As before, sight through the opening and route the cable over the lower pulley in the housing. Maintaining a small amount of tension on the cable, tape it to the arm housing just below the point where it exits the housing.

> *Note: Make sure that the cables remain in place on the pulleys as the next two sections are performed.*

D. REPLACE THE ARM

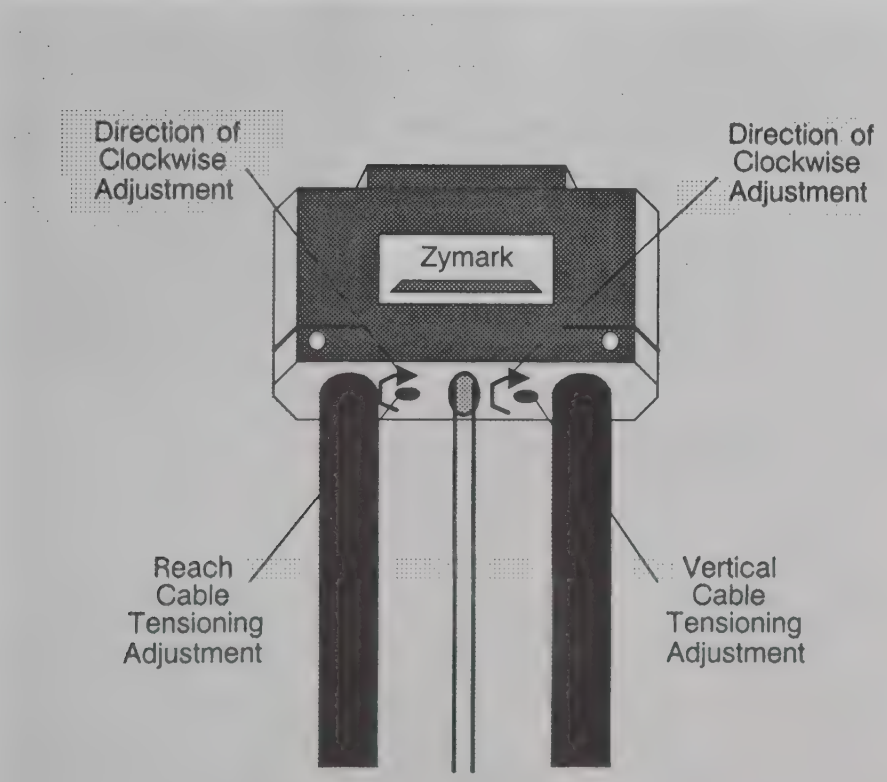
1. Carefully reinsert the arm back into the arm housing. Make sure the arm is inserted with the wrist nearest the side of the arm housing that holds the coil cord support.

E. ATTACH THE CABLES TO THE ARM

1. Pull the wrist end of the arm outward until the cable that is taped to the upper section of the arm housing can extend beyond the end of the arm (with the tape still in place).
2. Insert the black plug into the rear of the arm (threaded holes up).
3. With the tape still in place, capture the ferrule in the V-shaped cable retainer and secure the retainer, cable and black plug in place on the rear of the arm with the two Phillips screws previously removed.
4. Once secured, pull outward on the rear of the arm with just enough force to allow the cable to break the tape on the housing. Maintaining enough outward pull to keep the cable taut, apply pieces of tape across the arm housing and onto the arm. Do this on both the front and rear sections of the arm to insure that the arm does not move within the housing.
5. Pull the end of the lower cable away from the front of the arm housing until the cable breaks the tape on the housing. Maintain slight outward tension on the cable.
6. Capture the ferrule in the V-shaped cable retainer and secure it in place on the wrist end of the arm.
7. Loosen the compression screw in the column cap assembly until the top of the screw is even with the top of the column cap body.

F. TENSION THE CABLES

1. Remove the tape from the drum, pulley and arm housing.
2. Remove the arm housing support and let the arm settle to the bottom limits of its travel.
3. Turn the reach drive cable tensioning adjustment (located on the underside of the column cap assembly) COUNTER-CLOCKWISE until a slight resistance is felt. This resistance is the first contact between the adjusting screw and the cable-tensioning device within the column cap assembly.
4. Continue to turn the adjustment COUNTER-CLOCKWISE one more turn. When correctly adjusted, a force of approximately 2 lbs. should move the center of the cable .20 to .25 inch (.5 to .6 cm).
5. Reinstall the cover on the column cap assembly.

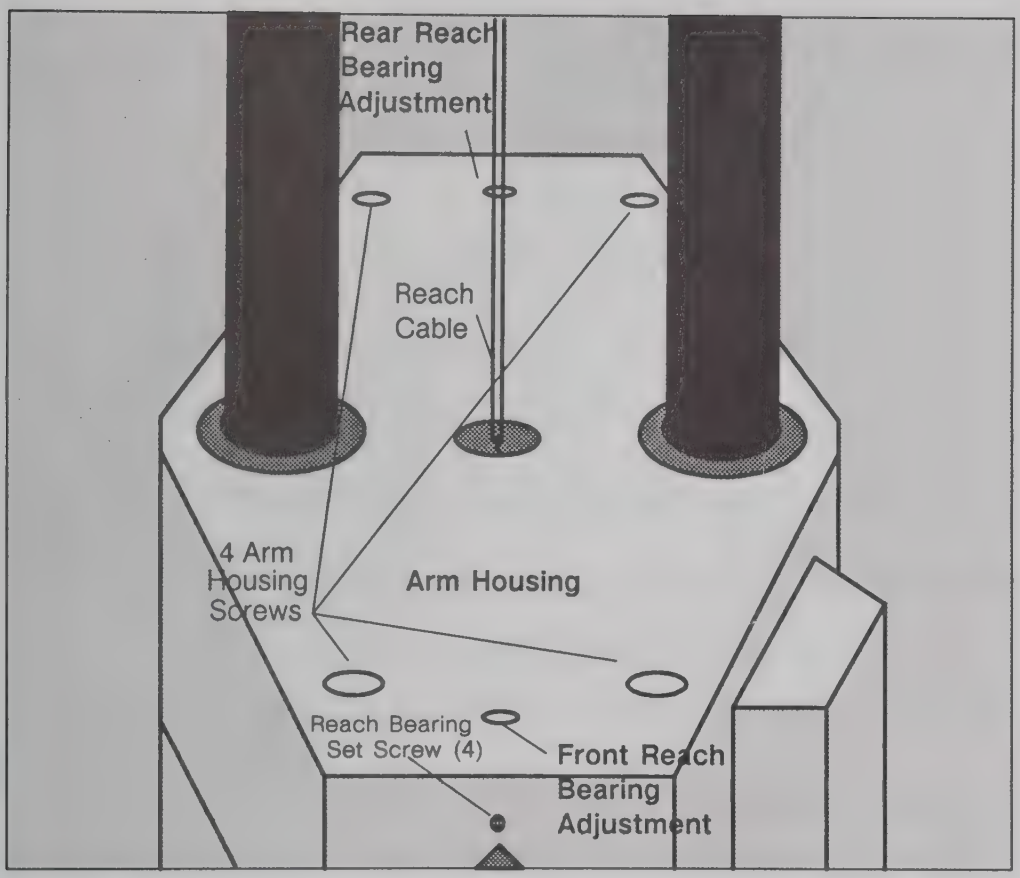


G. ADJUST THE REACH BEARINGS

1. Locate the four set screws that secure the reach bearings.* Two are located on the arm housing just above and below the point where the arm exits from the front of the housing. The other two are located exactly 180° opposite, at the point where the arm exits the rear of the housing.

   ** Robots built prior to 6/88 may not contain the securing set screws.*

2. Using the Allen wrench, loosen (approximately 2 turns) the four set screws.
3. Locate the two small holes on the top of the arm housing for bearing adjustment.
4. Using a small screwdriver, turn the front adjustment screw COUNTER-CLOCKWISE until snug.
5. Turn the screw CLOCKWISE (to loosen) 1/16 to 1/8 turn.
6. Repeat steps 4–5 for the rear adjustment screw.
7. Finally, retighten the four set screws until snug.
8. Check the adjustment:
   a. With the Controller and Robot power OFF, manually extend the arm through its full reach.
   b. Feel for any binding while moving the arm.
   c. Standing in front of the wrist box, check for any bearing sloppiness by rocking the wrist side to side.
   d. If binding or sloppiness is detected, readjust the bearings and re-check the adjustment.
   e. If either problem persists, call Zymark service.


Rear Reach
Bearing
Adjustment
Reach
Cable
4 Arm
Housing
Screws
Arm Housing
Reach Bearing
Set Screw (4)
Front Reach
Bearing
Adjustment

PROCEDURE 3: REASSEMBLE THE ROBOT

A. REPLACE THE COIL CORD

1. Reattach the coil cord support to the arm housing.
2. Reinstall the interconnection board.
3. Reinstall the two turntable covers.
4. Connect the cables to the interconnection board.
5. After untaping the coil cord tube assembly from the arm housing, pull the coil cord and grommet out of the notch in the coil cord tube and feed the cord into the wrist.
6. Slide the coil cord and tube into position within the wrist box and anchor the cord and grommet in the notch.
7. After aligning the tube, secure it in place by tightening the coil cord tube screw.

B. REINSTALL WRIST BOARD AND WRIST COVER ASSEMBLY

1. Plug the 4 connectors into the wrist electronics board.
2. Secure the board to the wrist box with the center screw.

C. SET THE REACH ZERO

1. Refer to R33, PROCEDURE 3 to reset the reach zero for the Robot.

> *Note: This procedure is critical to optimizing Robot performance.*

SYRINGE CHANGE PROCEDURE

PROCEDURE SCOPE:

This service procedure describes the steps required to replace, install or remove syringes in the two styles of Zymark Syringe Hands. Refer to the two figures on the next pages to determine which style hand(s) your Zymate System has. Figure A shows the hand style typical for most non-Py systems. Figure B shows the hand style typical for Py-configured systems. Earlier Syringe Hands with potentiometers and motors mounted on the side of the hand body are not covered in this procedure.

PARTS (AS REQUIRED):

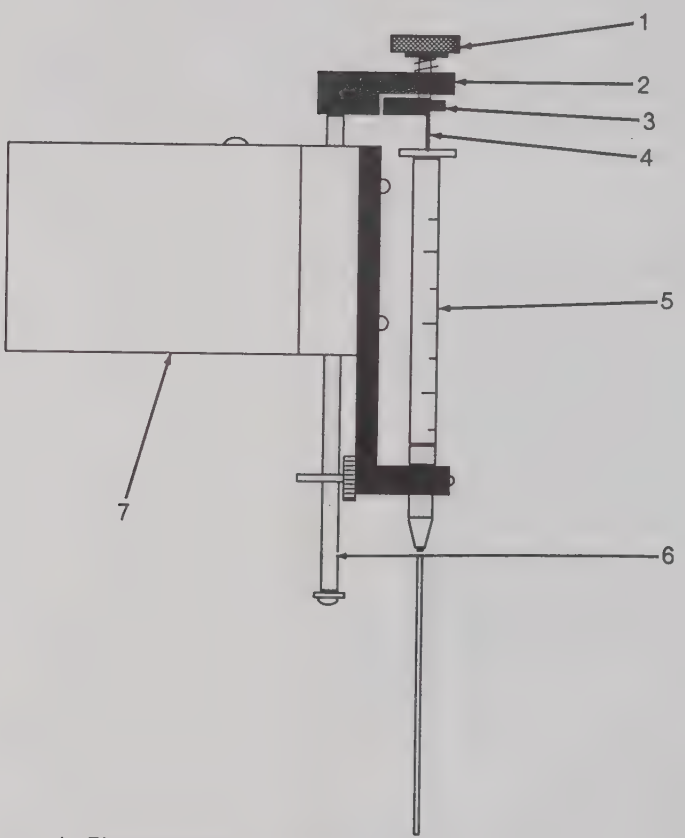
Syringe, 5ml P/N 36608
Syringe, 2.5ml P/N 36607
Syringe, 1ml P/N 36606
Syringe, 500ul P/N 36605
Syringe, 250ul P/N 36604
Syringe, 100ul, P/N 36603
Syringe, 50ul, P/N 36602
Syringe, 10ul, P/N 36863
Syringe, 5ul, P/N 36601
Syringe, 1ul, P/N 36600
Low Volume Syringe Bracket, P/N 37130

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8 inch

The A style Syringe Hand shown below, typical for most non-PySystems, is covered in Procedure 1 in this document. This style hand can accept microliter sized syringes with the addition of two types of mounting adaptors. Read the Syringe Bracket Notes, PROCEDURE 1, Section A for additional details and instructions on mounting various size syringes.

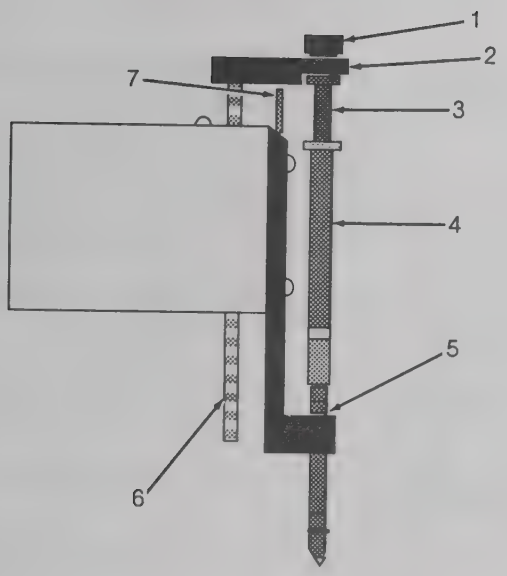
Figure A



1. Plunger knob
2. Plunger mounting block
3. Plunger adaptor
4. Plunger
5. Syringe
6. Gear rack
7. Hand body

Syringe Hand - style A

The B style Syringe Hand shown below, typical for PySystems, is covered in Procedure 2 in this document. Refer to the appropriate section(s) for removal, installation and adjustment.



1. Plunger knob
2. Plunger mounting block
3. Plunger
4. Syringe
5. Luer-lock fitting
6. Gear rack
7. Push rod

Syringe Hand - style B

PROCEDURE 1: SYRINGE REMOVAL AND INSTALLATION (A style hands)

A. SYRINGE BRACKET NOTES

Syringe sizes smaller than 1ml require using a small plunger adaptor in combination with a black plunger knob (used to press against the plunger).

Syringes 1ml and larger do not require the adaptor, however do require using a different plunger knob (with smaller diameter threads) that screws directly into the top of the plunger.

Both types of plunger knobs and the adaptor come standard with A style syringe hands.

Also, for syringe sizes of 10ul or less, a Low Volume Syringe Barrel Adaptor Kit is required in addition to the plunger adaptor.

Follow these steps when replacing or installing syringes using the A style hand:

1. Refer to the Mounting Hardware Chart below to determine the necessary syringe mounting hardware according to your syringe size.
2. Follow the appropriate syringe removal instructions (sections B and C) to remove the existing syringe from your hand.
3. If necessary, refer to sections D and E for installation/removal instructions for the plunger adaptor and/or Low Volume Bracket.
4. Next, refer to the syringe installation instructions (sections F – H) appropriate for your syringe.
5. Finally, go to section I for syringe adjustment instructions on all A style syringe hands.

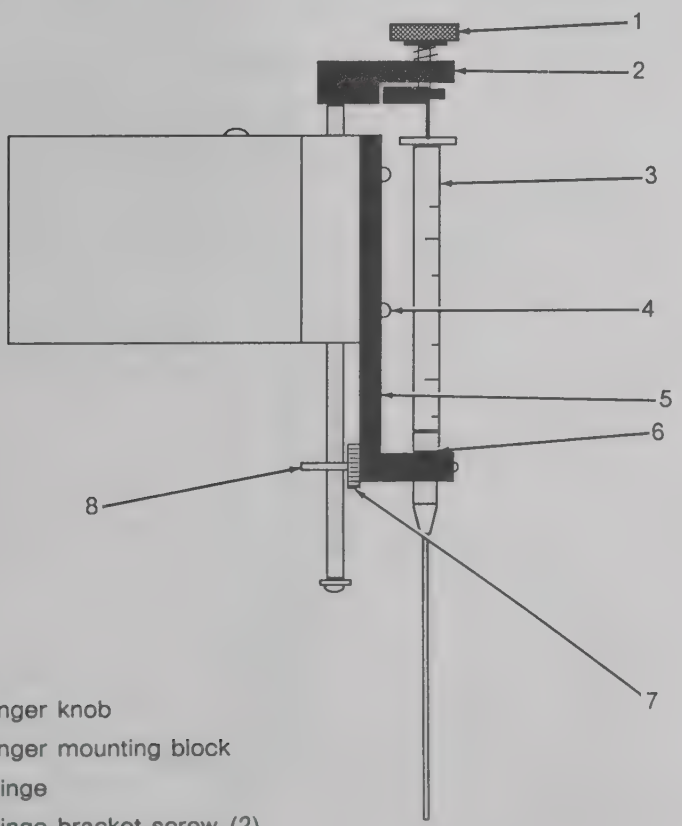
Mounting Hardware — Syringe Size — ▒ = Hardware Required

	1 ul	5 ul	10 ul	50 ul	100 ul	250 ul	500 ul	1 ml	2.5 ml	5 ml
Standard Bracket				▒	▒	▒	▒	▒	▒	▒
Plunger Knob with small dia. threads								▒	▒	▒
Plunger Adapter	▒	▒	▒	▒	▒	▒	▒			
Plunger Knob with large dia. threads	▒	▒	▒	▒	▒	▒	▒			
Low Volume Syringe Barrel Adaptor	▒	▒	▒							

MOUNTING HARDWARE CHART

B. SYRINGE REMOVAL (Syringes 50ul and larger)

1. Loosen and remove the black plunger knob on the top of the syringe plunger mounting block.
2. Loosen the silver knob holding the bar securing the bottom of the syringe in place.
3. Pull the bar outward and turn it so the syringe can be removed.
4. Carefully remove the syringe by pulling straight out on the Luer fitting.
5. Using a small flatblade screwdriver, loosen the two screws that fit in the syringe bracket slots.

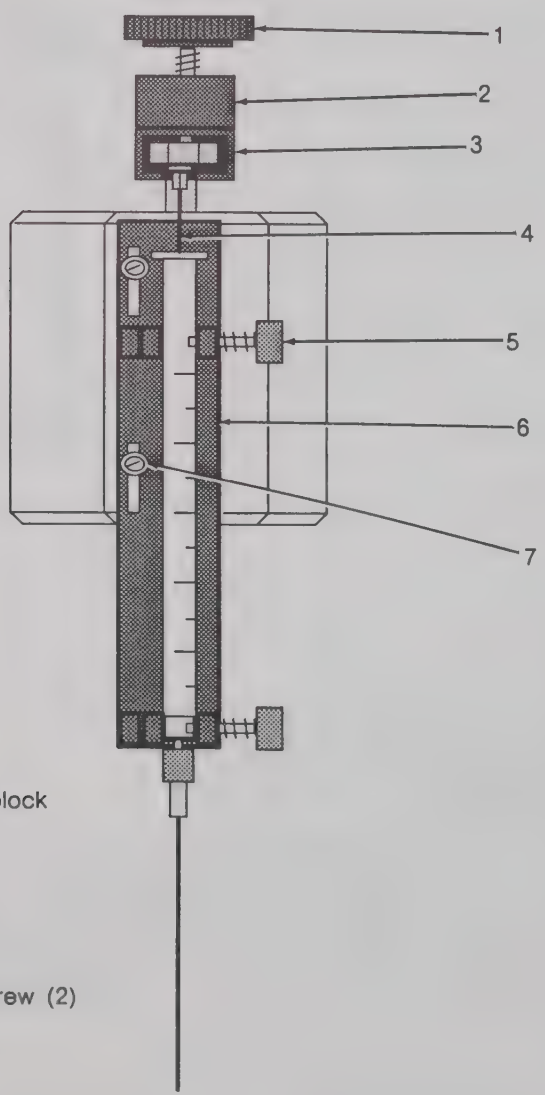


1. Plunger knob
2. Plunger mounting block
3. Syringe
4. Syringe bracket screw (2)
5. Syringe bracket
6. Luer fitting
7. Silver knob
8. Bar

C. SYRINGE REMOVAL (Syringes 1ul to 10ul using the Low Volume Syringe Bracket)

Refer to the diagram below for details.

1. Loosen and remove the black plunger knob on the top of the syringe plunger mounting block.
2. Loosen the two silver knurled knobs on the side of the bracket.
3. Pull the syringe straight out of the bracket.
4. Using a small flatblade screwdriver, loosen the two screws that fit in the syringe bracket slots.



1. Plunger knob
2. Plunger mounting block
3. Plunger adaptor
4. Plunger
5. Knurled knob (2)
6. Bracket
7. Syringe bracket screw (2)

D. INSTALL/REMOVE PLUNGER ADAPTOR

With the syringe removed from the hand:

1. Secure the plunger adaptor to the plunger mounting block by inserting the screw through the top of the block into the adaptor. Tighten securely.
2. To remove a plunger adaptor, simply remove the screw securing the adaptor to the plunger mounting block and set both aside.

E. INSTALL/REMOVE LOW VOLUME SYRINGE BARREL ADAPTOR

With the syringe removed and the plunger adaptor in place:

1. Using a flatblade screwdriver, remove the two small screws and brass washers that secure the standard bracket in place.
2. Place the Low Volume Bracket on the syringe hand with the slots to the left (the bracket has a track which fits into the groove on the syringe hand).
3. Insert the two screws and brass washers removed in step 1. Do not tighten at this time. The bracket will require adjustment after the syringe is in place.
4. To remove a Low Volume Bracket, simply remove the two screws and washers that secure the bracket to the hand.

F. SYRINGE INSTALLATION (Syringes 1ml to 5ml)

Using the standard bracket with NO plunger adaptor:

1. Run a program to attach the syringe hand to the Robot. From the Robot teaching screen, position the arm in a location that allows for convenient access to the hand.
2. From the Hand teaching screen, use function 7 to open the syringe to the 200 unit position.
3. With the two bracket mounting screws loose, slide the syringe fully into the bracket, with the Luer grooves on the syringe aligned with the bottom section of the bracket.
4. Secure the syringe in place with the bar and tighten the knurled knob.
5. From the Hand teaching screen, use the dispense function key to move the plunger mounting block until it makes contact with the top of the plunger.
6. Insert the black plunger knob (with the small diameter threads) into the top of the plunger mounting block and tighten it into the plunger.
7. Proceed to Syringe Adjustment PROCEDURE 1, Section I.

G. SYRINGE INSTALLATION (Syringes 50ul to 500ul)

Using the standard bracket WITH plunger adaptor:

1. With the two bracket mounting screws loose, slide the syringe fully into the bracket with the Luer-lock grooves on the syringe aligned with the bottom section of the bracket and the plunger head aligned within the plunger adaptor opening.
2. Secure the syringe in place with the bar and tighten the knurled knob.
3. Insert the black plunger knob (with the large diameter threads) into the top of the plunger mounting block and tighten until it presses securely against the plunger top.
4. Proceed to Syringe Adjustment, PROCEDURE 1, Section I.

H. SYRINGE INSTALLATION (Syringes 1ul to 10ul)

Using the Low Volume Bracket WITH plunger adaptor:

1. Loosen the two knurled knobs on the side of the bracket.
2. Insert the syringe into position so that the syringe plunger fully seats within the plunger adaptor and the bottom of the bracket aligns with the lower edge of the

shiny metal section of the syringe. (Slide the bracket and/or move the arm to facilitate the insertion).

3. Gently snug the upper knurled knob against the glass surfaces of the syringe and firmly tighten the lower knurled knob against the metal section of the syringe.
4. Insert the black plunger knob into the top of the plunger mounting bracket and tighten until it presses securely against the plunger top.

I. SYRINGE ADJUSTMENT (All A style syringe configurations)

1. Run a program to attach the Syringe Hand to the Robot.
2. Using the Robot's teaching screen, close the syringe to the zero position.
3. Adjust the syringe by sliding the bracket up or down until the bottom of the plunger is just above its physical stop.

> **CAUTION: The plunger should NOT be set to stop at the very bottom of the syringe. Doing so may cause a malfunction as the hand attempts to find an unreachable zero position. Set the plunger to stop one graduation before the zero position. The hand displaces liquid or air by tracking the number of steps taken and is not affected by the graduations on the barrel.**

4. Tighten the two mounting screws that hold the bracket in place.

PROCEDURE 2: SYRINGE REMOVAL AND INSTALLATION (B style hands)

A. SYRINGE REMOVAL

1. Grasp the plunger and turn (CCW) the plunger knob the attaches the plunger to the plunger mounting block. Loosen it several turns, but do not fully remove it yet.
2. Turn the syringe barrel (CCW) to disengage it from the Luer-lock fitting.
3. Finish removing the plunger knob and fully detach the syringe.

B. SYRINGE INSTALLATION

1. Insert the plunger knob through the plunger mounting block and into the plunger. Turn several times (CW) but do NOT fully tighten. This aids in syringe alignment for the next step.
2. Next, push the syringe barrel into the Luer-lock fitting. Apply downward pressure on the Luer-lock while turning the barrel CW. Tighten the barrel only finger tight: DO NOT USE TOOLS. Excessive force can strip the brass threads in the end of the syringe barrel.
3. Check that the graduations on the barrel face outward. If not, re-orient the syringe and perform step 2 again.
4. Finally, grasp the plunger and tighten the plunger knob securely.

C. SYRINGE ADJUSTMENT CHECK

1. Run a program to attach the Syringe Hand to the Robot.
2. Enter the Robot teaching screen and move the syringe axis until the pushrod is just contacted by the syringe plunger mounting block.
3. Read the syringe axis value from the teaching screen. Verify that the value falls within the 27 to 33 unit range. If not, refer to R96 for setting the Syringe Hand zero.

GP HAND ADJUSTMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the gain and zero position adjustments for GP Hands.

PARTS REQUIRED:

None

TOOLS REQUIRED:

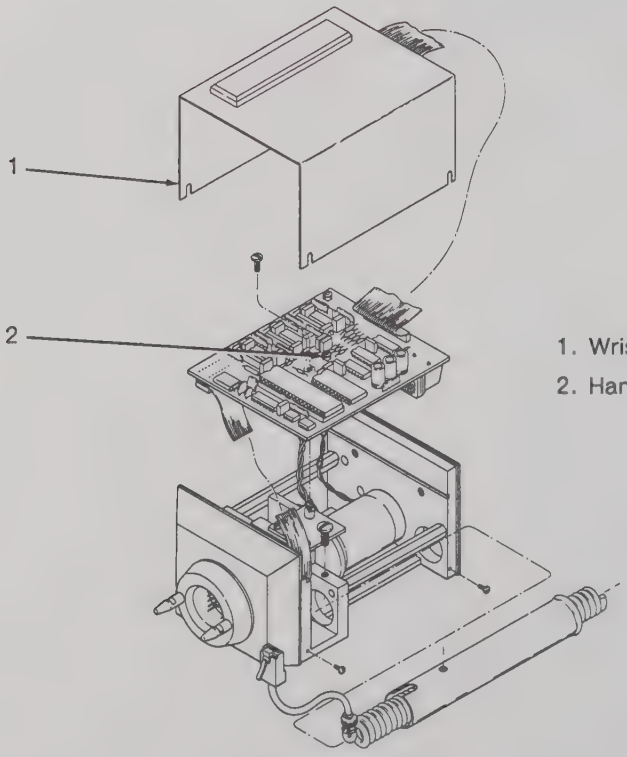
Screwdriver, blade,
Screwdriver, precision, blade 1.2mm

PROCEDURE 1: GP HAND GAIN ADJUSTMENT – ZYMATE II ROBOTS*

With the GP Hand attached to the wrist:

1. Loosen the four screws securing the cover. Carefully lift the cover and "hinge" it back so that it rests on the Robot arm.
2. Locate the GP Hand gain adjustment pot (R5) in the center of the wrist board.
3. Enter the Robot Hand screen and use the "OPEN" function key to open the fingers 30 units.
4. Using a small flatblade screwdriver, turn the gain pot CW until the fingers oscillate. Then slowly turn the pot CCW until the oscillation just stops. Continue turning the adjustment CCW an additional 1/8 turn.
5. Recheck the gain.
6. Reinstall the wrist cover.

*Zymate I Robots have no GP Hand gain adjustment.



1. Wrist box cover
2. Hand gain adjustment

PROCEDURE 2: GP HAND ZERO ADJUSTMENT – ZYMATE I & II ROBOTS

With the GP Hand removed from the wrist:

1. Locate the four screws on the rear section of the GP Hand. Remove the two LARGER screws. (The two smaller screws function to keep the rear hand section intact).
2. Separate the rear section from the main body of the hand.

> **CAUTION: Do not exert excessive tension on the wires connecting the two separated hand sections.**

3. Carefully "hinge" the rear section to the side to allow access to the two screws holding the pot in place. Note that the pot is the component with three wires attached.
4. Slightly loosen both pot–holding screws so that the pot can be finger turned.
5. With the Robot's wrist in the zero position, and the Hand teaching screen displayed, carefully place the rear section of the hand on the wrist, while at the same time supporting the main body of the hand.
6. From the teaching screen, set the grip to zero.
7. Grasping the solder lugs on the top of the pot, turn the pot body until the fingers separate approximately 1/4 inch.
8. Slowly turn the pot body in the opposite direction until the fingers just touch.
9. Without affecting adjustment, use a small flatblade screwdriver to tighten one of the pot-holding screws.
10. Carefully remove the hand from the wrist and tighten the second pot-holding screw.
11. Align the two hand sections together. (It may be necessary to tuck the wires into the cavity above the pot).
12. Insert the two screws removed in step 1 and secure the two sections together.
13. Run a program to reattach the GP Hand to the wrist and verify that the fingers are touching in the zero grip position. If not, readjust as necessary.
14. Refer to section 3 of the "ZYMATE I/II ROBOT AND HAND PERFORMANCE CHECK"to properly check the GP Hand zero set in the above steps.

SYRINGE HAND ADJUSTMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the gain and zero position adjustments for syringe hands.

PARTS REQUIRED:

None

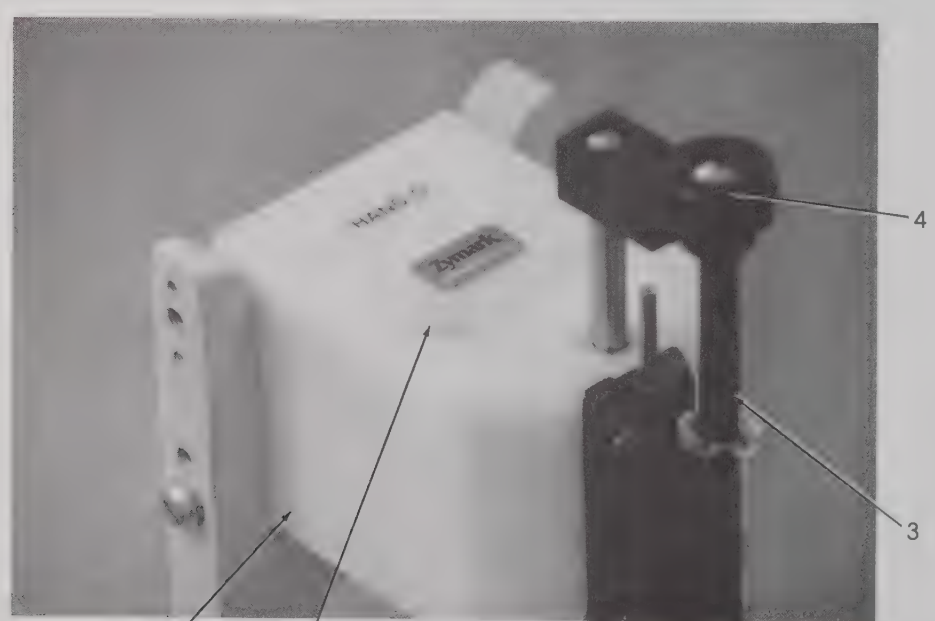
TOOLS REQUIRED:

Screwdriver, blade, 1/8"
Screwdriver, precision, 1.2mm
Marker, felt tip

PROCEDURE 1: SYRINGE HAND GAIN ADJUSTMENT

With the Syringe Hand removed from the wrist:

1. Loosen and remove the knob that attaches the syringe plunger to the gear rack mechanism.
2. Run a program to attach the Syringe Hand.
3. Enter the Hand teaching screen and use the "FILL" function key to raise the gear rack mechanism 10 units.
4. Remove the small plastic plug from the top of the Syringe Hand to allow access to the gain pot adjustment screw.
5. Using a small screwdriver, turn the gain pot adjustment CW until the syringe oscillates. Then slowly turn the adjustment CCW until the oscillation just stops. Continue turning the adjustment CCW an additional 1/8 turn.
6. Reinstall the knob.
7. Recheck the gain.
8. Reinstall the plastic plug.



1. Syringe hand
2. Plastic plug
3. Plunger
4. Knob

PROCEDURE 2: SYRINGE HAND ZERO ADJUSTMENT

It is recommended that two people perform the following procedure. The Syringe Hand must be partially disassembled and supported in place on the wrist while simultaneously adjusting and tightening the potentiometer.

With the Syringe Hand removed from the wrist:

1. Facing the connector end of the hand, mark one of the wrist pin latches protruding from the bottom of the hand*. Next, in the same area, mark the middle and rear Delrin sections of the hand. Marking in this manner will insure correct reassembly of the Syringe Hand.

   **Use a felt tip marker.*

2. Using a flatblade screwdriver, remove the four screws securing the rear section of the hand.

3. With the Syringe Hand placed on a flat surface, (in order to catch any wrist pin latches and springs that are likely to fall out), carefully separate the rear section from the hand.

4. If any latches and springs are still in place, remove them and place them along with the four screws in a convenient location.

> **CAUTION: Do not exert excessive tension on the wires connecting the two separated hand sections.**

5. Carefully "hinge" the rear section back to allow access to the four long screws securing the middle section to the main body of the hand.

6. Using a flatblade screwdriver, remove the four screws and gently move the middle section away from the main body to allow access to the two screws that secure the pot in place. Note that the pot is the component with three wires attached.

7. Slightly loosen the two pot holding screws so that the pot can be finger turned.

8. With the Robot's wrist in the zero position, and the Robot's Hand teaching screen displayed, carefully place the rear section of the hand on the wrist, while at the same time providing support to the middle and front sections.

> **CAUTION: Make sure that the bottom of the hand's rear section (with cutouts for the wrist pin latches) faces downward.**

At this point, it is recommended that one person holds the front section of the hand (allowing access to finger-turn the pot), while a second person holds the middle and rear hand sections, making sure the rear section remains flush against the wrist coupling.

9. From the Robot's Hand teaching screen, set the syringe value to 200 units.
10. Turn the pot body until a 1/16 inch gap exists between the bottom of the hand body and the inside of the washer on the lower-end of the gear rack.
11. Carefully, without moving the pot, tighten the two pot holding screws. Verify that the 1/16 inch gap still exists.
12. Slide the hand off the wrist.
13. Using the four long screws, reassemble the middle section of the hand.
14. Place the springs back into the holes at the top of the wrist pin latches.
15. Slide the latches with springs into the slots in the rear section. Be sure that the spring-ends fit into the holes at the top of each slot. Also check that the latch with the mark aligns with its corresponding mark on the rear hand section.
16. Carefully, without disturbing the spring-loaded latches, align the rear section with the middle section and replace the four screws. Insure that the marks on both sections align.

> *Note: It may be necessary to tuck some of the wires into the cavity of the middle hand section in order to align the rear section properly.*

ROBOT SPECIFICATIONS

A. General Specifications

Physical Size:	Height	27.5 in (70 cm) overall
	Base	12.3 in (32 cm) square
	Arm	25.6 in (65 cm) long
Degrees of Freedom:	Base & Wrist	4
	Hands	1 or 2 additional
Axis Positioning	Servo motor driven/potentiometric feedback	
Lifting Capacity	3 lbs (1.4 kg)	
Hands	Auto-changable	
Operating Weight	38 lbs (17 kg)	
Shipping Weight	75 lbs (34 kg)	

B. Environmental Specifications

Mains Voltage	100, 120, 220, 240 VAC $\pm$ 10%
Mains Frequency	48 – 62 Hz
Power Consumption	60 VA max
Operating Temperature	+10 degrees to +30 degrees C
Relative Humidity	10 – 90%
Safety	Not to be used where explosive concentrations of flammable vapors can accumulate
Corrosive Materials	Standard Z110 Robot is not intended to handle corrosive materials
	Z110E version Robot provides corrosion resistant materials and purge capability for mildly corrosive environments
Mounting	Upright on flat, horizontal surface

C. Performance Specifications

Repeatability (same direction):	Rotary @ 27 in radius	± .02 in (0.5 mm) max
	Vertical	± .01 in (0.25 mm) max
	Reach	± .01 in (0.25 mm) max
	Wrist	± .02 in (0.5 mm) max
Repeatability (opposite direction)	Rotary @ 27 in radius	± 0.00 to 0.08 in (2.0 mm) overlap max
	Vertical	± .02 in (0.5 mm) max
	Reach	± .02 in (0.5 mm) max
	Wrist @ 6 in radius	± .04 in (1.0 mm) max
Warm – up Error Rotary Axis @ 27 in radius:	Zero (0) degrees	< 0.02 in (0.5 mm)
	Span (360) degrees	0.055 in (1.3 mm) typical
Temperature Error Rotary Axis @ 27 in radius	Zero (0) degrees	< 0.02 in (0.5 mm)
	Span (360) degrees	0.040 in (1.0 mm)/ 10 degrees C typical
Vertical – Reach Interaction	± 0.15 in (4.0 mm) max reach change during full vertical move	

D. Operating Characteristics

Axis Displacement	Rotary	$376^0 \pm 4^0$
	Vertical	34.0 cm ±0.5 cm (13.4" ±0.2")
	Reach	32.0 cm ±0.5 cm (12.6" ±0.2")
	Wrist	$370^0 \pm 5^0$ ($360^0 \pm 5^0$ for Zymate I)
Reach Radius (at maximum)		27.0" (68 cm) typical (with gp hand)

Axis Speed (typical – including one – axis communication time)

Rotary		5.2 sec/360^0	(10.4 sec for Zymate I)
Vertical	UP	4.3 sec/34cm	(8.5 sec for Zymate I)
	DOWN	2.9 sec/34cm	(5.8 sec for Zymate I)
Reach		0.9 sec/32cm	(1.8 sec for Zymate I)
Wrist		2.2 sec/365^0	(4.0 sec for Zymate I)

Axis Operating Forces (typical force vs. position error)

Rotary		0.4 oz/0.1^0 (at 27" radius)
Vertical	UP	3 lbs (1.3 kg)/2 mm error
	DOWN	1 lbs (0.4 kg)/1 mm error
Reach		1 lbs (0.4 kg)/1 mm error

Axis Stall Forces (typical maximum force required to stall an axis)

Rotary		3 lbs (1.4 kg) (at 27" radius)
Vertical	UP	20 lbs (9 kg)
	DOWN	30 lbs (14 kg)
Reach		9 lbs (4 kg)
Wrist		10 in–lbs

E. Material Specifications

Drive Cables	Material	HT SS: 7 bundles, 19 strands/bundle, nylon jacket
	Rating	160 lbs (used at 15 lbs typ)
Bearings		
	Type	ball or tapered roller bearing assemblies
	Lubrication	permanently lubricated
Motors		
	Type	permanent magnet, d–c, brush–type, servo motor
	Gear Reduction	integral gear reduction housing

	Rotary	65.5:1
	Vertical	65.5:1
	Reach	19.7:1
	Wrist	187:1
Potentiometers		
	Base Axis Position	10 turn, hybrid element, servo mount (2k or 10k)
	Wrist Position	1 turn, conductive plastic, servo mount (2k)
Arm		Stainless Steel, abrasive ground
Posts		Steel, centerless ground, oxide passivated
Lubrication (arm & posts)		SAE 30 automotive-type engine oil, or equivalent

F. Adjustment Specifications (Specification Range for User Adjustments)

Cable Tension (deflection for 2 lbs lateral pull)

Rotary	.04-.08" (.1-.2 cm) for longer cable section
Vertical	.20-.25" (.5-.6 cm) arm at mid-vertical position
Reach	.20-.25" (.5-.6 cm) arm at mid-vertical position
Servo	.15-.20" (.4-.5 cm) either cable section

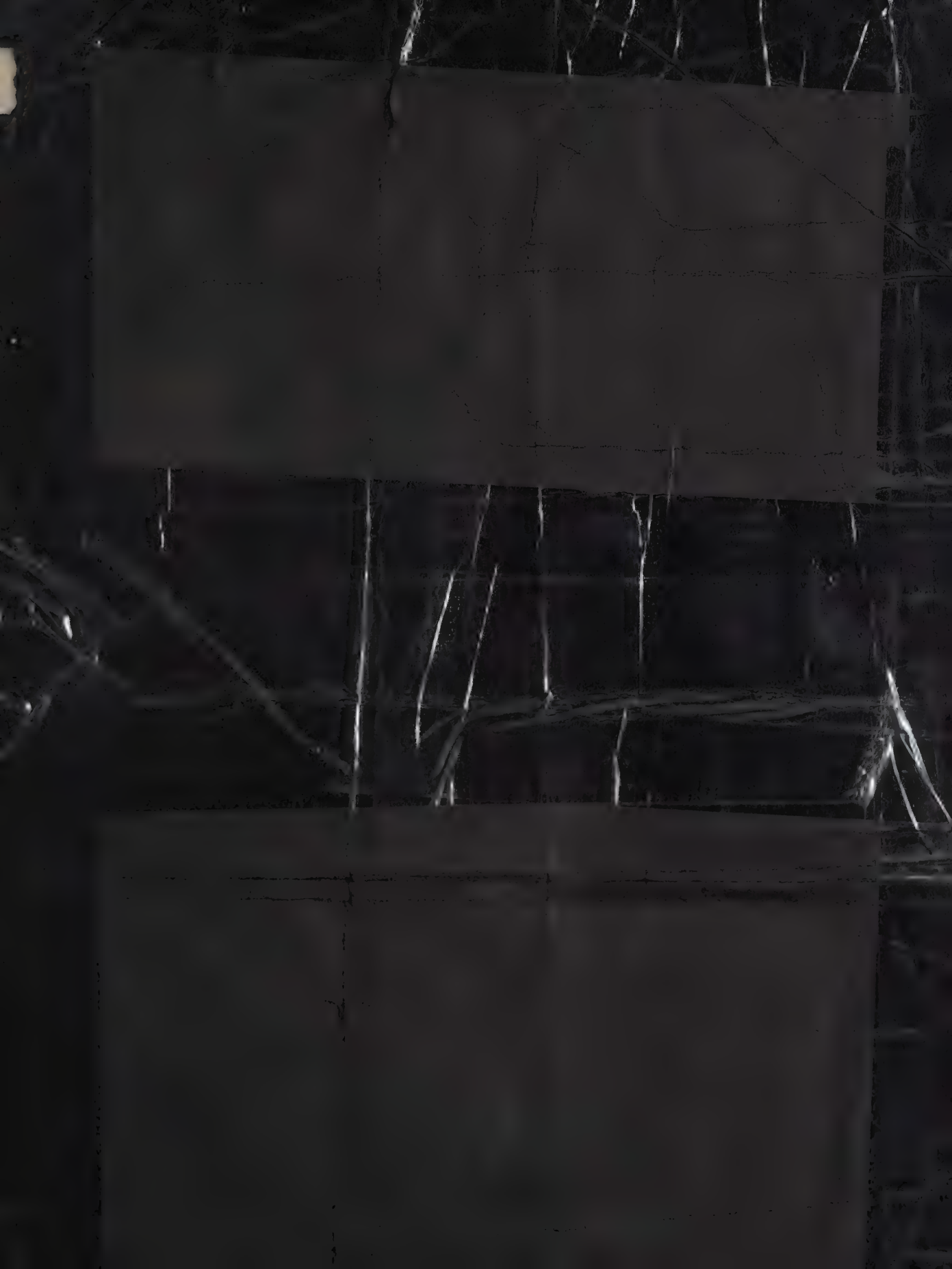
Power Supply Voltages

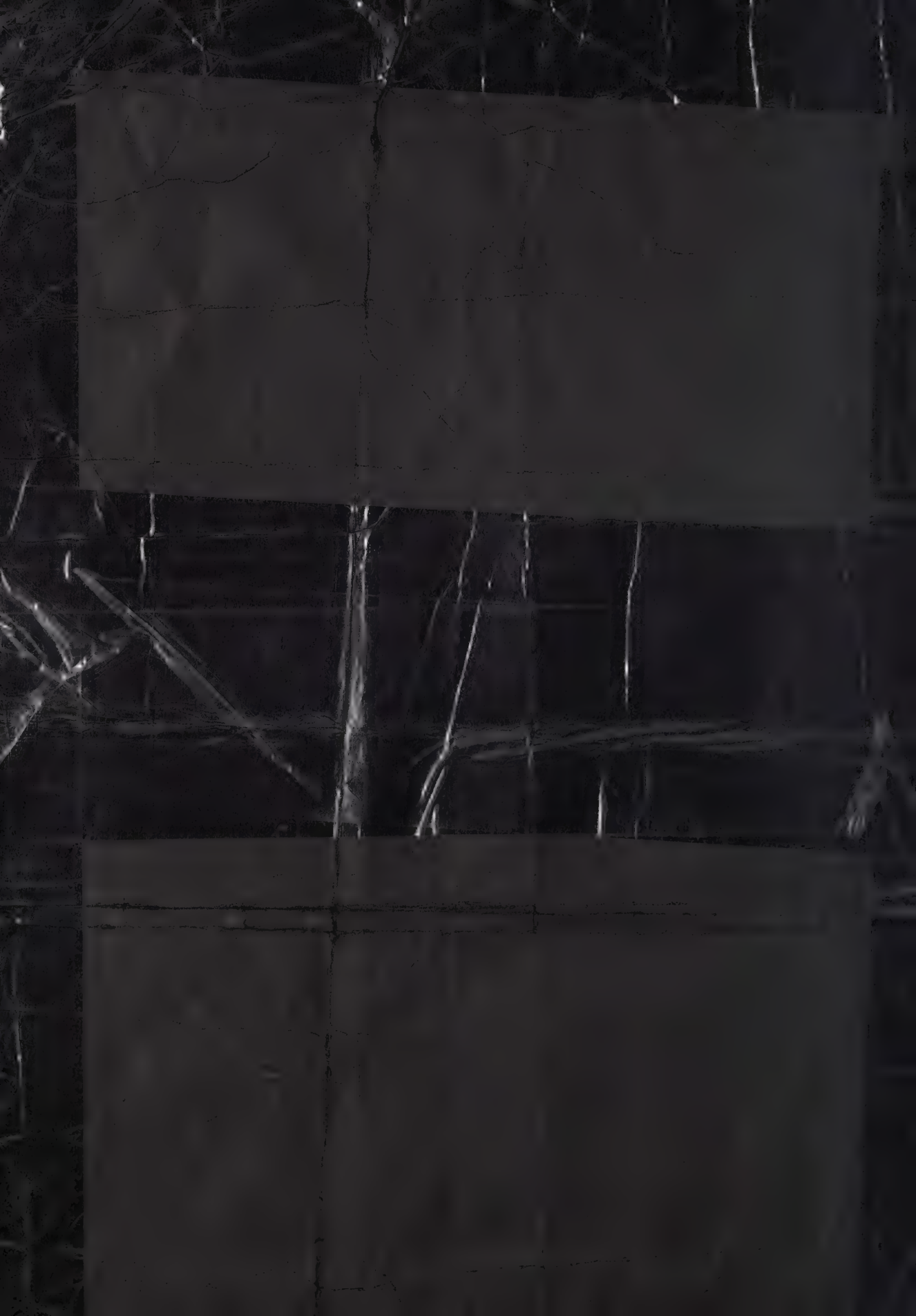
Base Board

	ZY II	ZY I
+12B	+12.9 to +14.9 VDC	+13.6 ± 0.1 VDC
-12B	-12.9 to -14.9 VDC	-13.6 ± 0.1 VDC
+5B	+4.7 to +5.3 VDC	+5.0 ± 0.1 VDC

Wrist Board (measured with hand removed and wrist motor unplugged)

	ZY II	ZY I
+12W	+12.6 to +14.8 VDC	+13.6 ± 0.1 VDC
-12W	-13.0 to -15.2 VDC	-13.6 ± 0.1 VDC
+8W	+7.4 to +8.8 VDC	+8.0 ± 0.1 VDC
+5W	+4.7 to 5.3 VDC	+5.0 ± 0.2 VDC





Axis Zero Position

Rotary	0 $\pm 1^0$ (arm perpendicular to baseplate rear)
Vertical	2.2 $\pm$ 0.05" (arm housing parting line to turntable cover top)
Reach (at mid-vertical)	0.9 $\pm$ 0.05" (wrist box rear surface to arm housing)
Wrist zero	0 $\pm$ 0.25^0 (pins parallel to bench surface .05"/12")
Wrist Vertical	Coupling face perpendicular to a flat bench within .002"

G. Diagnostic Specifications

Axis Motor Current

Average current measured using a voltmeter across the motor's .47 ohm current sampling resistor during a full-scale axis move.

Rotary	
CW	240 ma max
CCW	240 ma max
Vertical	
UP	480 ma max
DOWN	120 ma max
Reach	
OUT	360 ma max
IN	280 ma max

Master Laboratory Station

Section 1: Theory of Operation

Master Lab Station Theory of Operation

Section 2: Performance

Master Lab Station Performance Check

Section 3: Troubleshooting

Master Lab Station Troubleshooting Guide

Section 4: Repair/Replacement

M14 MLS Syringe Change Procedure
M19 Microswitch Replacement Procedure
M20 Bladeswitch Replacement Procedure
M29 Manual Stop Adjustment Procedure
M44 Stepper Motor Replacement Procedure
M60 Printed Circuit Board Replacement Procedure
M72 Valve Change Procedure
M88 Turntable Installation Procedure
M91 Gas Valve Replacement Procedure

Section 5: Specifications

Robot Specifications

MASTER LAB STATION INDEX

Description	Perform. Check pg. no.	Trouble Guide pg. no.	Proc. No.
BLADESWITCH			
Adjustment			M20
Replacement			M20
GAS VALVE			
Replacement			M91
INITIALIZATION			
Failure to	2	2	
Common Causes		2	
Localizing Failure		2	
MANUAL STOP			
Adjustment			M29
Proper Setting			M29
MICROSWITCH			
Proper Location			M19
Replacement			M19
PC BOARD			
Replacement			M60

Description	Perform. Check pg. no.	Trouble Guide pg. no.	Proc. No.
PERFORMANCE			
Communications Check	2		
Syringe Operation	3		
STEPPER MOTOR			
Replacement			M44
SYRINGE			
Change			M14
Fast Speed Check	4		
Slow Speed Check	4		
TUBING			
Fitting Replacement	5	3	
Tubing Replacement	5	3	
TURNTABLE			
Installation			M88
Use of Jumper			M88
VALVE			
Cleaning	4		
Flushing	4		
Leakage	3		

Description	Perform. Check pg. no.	Trouble Guide pg. no.	Proc. No.
Operational Check			
Syringe	6		
Gas	6		
Particulates In	6	4	
Replacement			M72

MASTER LAB STATION
THEORY OF OPERATION

INTRODUCTION

The ability of the Master Laboratory Station to accurately and precisely deliver a specific volume depends on the handling of several issues as they relate to liquid handling.

In general, achieving good liquid handling performance (that is, accurate and precise liquid transfer) requires that a few simple guidelines be followed:

- Size of the syringe installed is selected so that the smallest amount of liquid handled is greater than 20% of the syringe capacity.
- Syringe speed does not exceed 1 ml/sec for liquids having a viscosity approximately that of water.
- Solvents should be degassed.
- Mechanical looseness (backlash) in the syringe mechanism is eleminated by overfilling at least 2% of the desired volume with the excess discharged back into the reservoir prior to dispensing.

SYRINGES

Each syringe is driven by a separate stepper motor. The stepper motor drives a lead screw that controls a syringe operating lever. This drive mechanism takes 910 steps to bring the syringe plunger through full stroke, with full stroke being a point furthest from the zero mark.

The volume deliverable by one step of the motor varies according to the size of the syringe installed. The smallest dispensable volume of any installed syringe is 1/910 of its volume. With a 1 ml syringe, this volume is slightly more than 1 ul.

With a 10 ml syringe, this volume is almost 11 ul. This impacts the accuracy of the amount delivered.

By selecting a syringe where the expected minimum volumes to be delivered are at least 20% of the syringe size (200 ul for a 1ml syringe, 2 ml for a 10 ml syringe), the maximum inaccuracy of the amount delivered based on the syringe alone would be less than 0.5%.

There is a slight amount of gear lash that exists at the bottom of a draw stroke when the motor reverses to drive in the opposite direction. This "backlash" consumes a number of motor steps and corresponds to a loss in volume of approximately 2%.

The syringe must be programmed to overfill at least 2 % of the volume to be delivered and discharge the excess back into the reservoir prior to dispensing. Additional backlash in the Master Laboratory Station can also be associated with looseness in any of the following:

- **Thrust Bearing** (found around shaft on top of motor)

  Contributes a minimum of 0.1% error (with the thrust nut snug). The error will typically be greater on older units.

- **Block & Bearing** (located behind the plunger drive lever)

  Typically 0.5%. Not adjustable by operator.

- **Plunger Thumbscrew**

  With thumbscrew tight, 0%. However, the thumbscrew often loosens with use. It should be secured as tight as possible with fingers at all times.

- **Luer Lock Mount**

  With crossbar tight, 0%. With crossbase loose, up to 1%. The crossbar functions to wedge the syringe into its housing on the Master Laboratory Station making it motionless. Any looseness in the crossbar allows vertical play resulting in an unpredictable bakclash situation. This translates to a loss in precision.

Teflon 3-Way Valves

The teflon 3-way valves connected to each syringe offer bi-directional pathing through two separate ports. These ports are referred to as RESERVOIR and NOZZLE. The connection to the syringe is COMMON to both ports, and is always used as the syringe connection.

Liquids should be drawn through the RESERVOIR port and dispensed either through the NOZZLE port (dispensing) or back through the RESERVOIR port (pipetting).

Upon Zymate System power up, the Master Lab Station undergoes an initialization process. At this time all syringes move to their respective "zero" locations with the NOZZLE port selected. Should system power be lost with liquids in any of the syringes, draining will always occur through the RESERVOIR port, regardless of port selection.

Degassing

The formation of air bubbles in a fluid line is affected by both temperature and pressure. Higher pressures and lower temperatures increase the amount of gas that can be dissolved in a liquid. A decrease in pressure (as when solutions are drawn into tubing) has to be balanced by a decrease in temperature in order to keep gas in solution. By minimizing the amount of gas that can dissolve in a liquid, the number of air bubbles in a line can be significantly reduced.

Liquid Transfer

The pressure required to move a liquid at a given flow rate is directly proportional to the viscosity of the liquid. The standard unit of measure of viscosity is the centipoise. A solution with a viscosity of 2 centipoise, has twice the back pressure of water and needs twice the force to move it at the same flow rate.

PRESSURE = FLOW RATE * VISCOSITY * LENGTH/RADIUS 4

A pressure drop results when there is a flow through a restriction. The restriction in the Master Lab Station occurs at the 3-way valve. Moving a liquid at too fast a flow rate causes a large pressure drop to occur. This can cause a vacuum or air bubbles to form. Limiting the pressure drop by slowing the syringe speed can eliminate vacuum and air bubble formation. The flow rate for a viscous liquid should be reduced even further. The maximum flow rate for any liquid should therefore be:

MAX FLOW RATE (cc/sec) = 5 / VISCOSITY (in centipoise)

GAS TRANSPORT

A single gas solenoid valve is provided and may be operated independent of the syringes. There are inlet/outlet tubing connections located on the front panel of the Master Lab Station. This valve is operated under program control and is rated to 100 psi.

MASTER LABORATORY STATION
PERFORMANCE CHECK

PROCEDURE SCOPE:

The following performance check procedures may be used to verify that the Master Laboratory Station IS or IS NOT functioning properly.

This performance check verifies:

1. Communication between the Zymate Controller and the Master Laboratory Station
2. Syringe operation
3. Valve operation

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Procedures for the replacement of parts are provided as well as in-depth troubleshooting information in this chapter of the Zymark Service Manual.

TOOLS REQUIRED:

None

PROCEDURE 1: COMMUNICATIONS CHECK

1. Turn the Controller's power OFF.
2. Plug the Master Lab Station module card into the support board on the Controller.
3. Connect the communications cable and power cord.
4. Turn the Master Lab Station's power ON.
5. Turn the Controller's power ON.

_____a. Wait for the Robot to initialize.

Confirm Robot initialization by successfully entering and leaving the Robot teaching screen.

CORRECTIVE ACTION

The Robot may fail to initialize if any system module is unplugged, turned off or operationally defective. Troubleshoot to find which module is defective by removing modules from the system in some sequence until the defective module is isolated.

To isolate the module:
1. **Turn the Controller's power OFF.**
2. **Remove all module cards from the Controller.**
3. **Plug in a single Zymate module card.**
4. **Turn the Controller's power ON.**
5. **Verify that the module initialized by displaying its teaching screen found under Bench and module setup.**
6. **Repeat 1-5 above for each module.**

WHEN THE DEFECTIVE MODULE HAS BEEN ISOLATED, REFER TO THE PERFORMANCE CHECK SECTION IN THE MANUAL FOR THAT MODULE FOR THE APPROPRIATE ACTION.

_____b. Select the Bench and module screen and verify that the Master Lab Station is listed.

CORRECTIVE ACTION

If the Master Lab Station is not listed as a module on the Bench and module setup screen, the module card, communication cable or module support board may be installed incorrectly or be defective.

1. **Make sure that all boards are firmly seated in their respective connectors.**
2. **Try alternate connectors.**
3. **If all else fails, replace the module card for the Master Lab Station.**

PROCEDURE 2: OPERATIONAL CHECK – SYRINGE

A. VERIFY THAT EACH SYRINGE RESPONDS TO COMMANDS

1. Select syringe A using the SELECT SYRINGE function key.
2. Using the SET VOLUME function key, set the volume for syringe A to equal the maximum volume of the syringe in the A position.
3. Press the RUN function key.

_____4. Verify that the syringe plunger moves to the maximum graduation on the syringe barrel.

CORRECTIVE ACTION

- **The syringe plunger may not move to the desired location if the SYRINGE SIZE value displayed on the Master Lab Station teaching screen does not correspond to the size of the installed syringe.**

5. Set the volume for syringe A to zero.
6. Press the RUN function key.

_____7. Verify that the syringe returns to the zero position.

_____8. Verify that the syringe does NOT vibrate once it reaches its "home" position.

_____9. Repeat steps 1 to 8 for syringes B and C, using the appropriate syringe volumes.

CORRECTIVE ACTION

- **The zero position should be set so that there is a slight gap between the end of the plunger and the syringe barrel. This ensures that the electrical stop is tripped before the plunger reaches its physical stop. Refer to M29 MANUAL STOP ADJUSTMENT procedure for more information.**

B. FULL STROKE OPERATION AT A FAST SPEED

1. Select syringe A using the SELECT SYRINGE function key.
2. Using the SET VOLUME function key, set the volume for syringe A to equal the maximum volume of the syringe in the A position.
3. Set the stroke speed for syringe A to the value as in step 2 using the SET TIME funciton key.
4. Press the RUN function key.

_____5. Verify that the syringe operates smoothly

6. Set the volume for syringe A to zero.
7. Press the RUN function key.

_____8. Again, verify that the syringe operates smoothly.

_____9. Repeat steps 1–8 for syringes B and C, using the appropriate syringe volumes.

CORRECTIVE ACTION

- **If "chattering" occurs, lubricate the syringe plunger with the solvent or liquid being used in that syringe.**
- **Selecting a time which gives a greater than 1ml/sec fill or dispense may cause "chattering" and/or slippage of the plunger.**

C. SYRINGE OPERATION AT SLOW SPEEDS

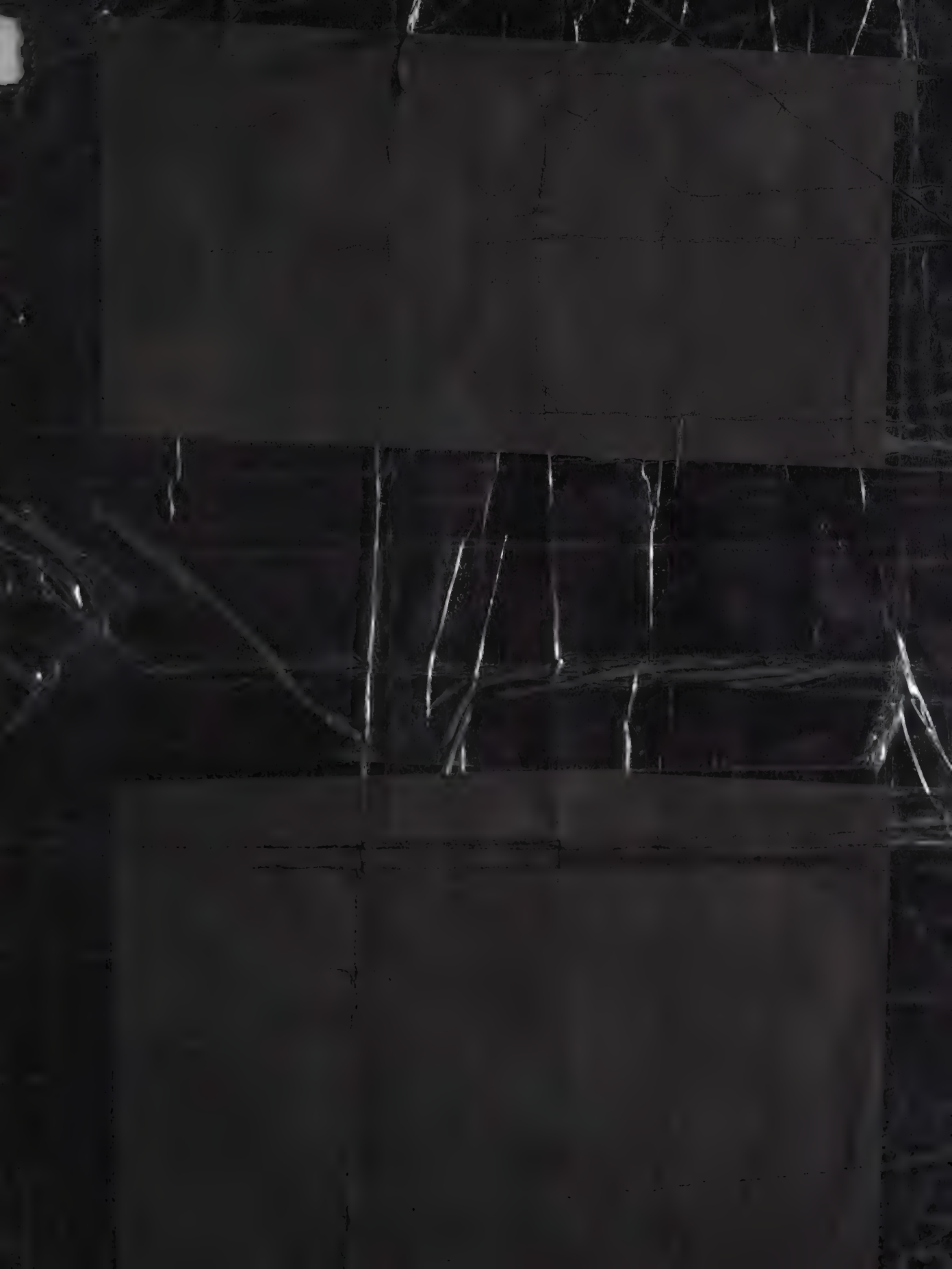
1. Select syringe A using the SELECT SYRINGE function key.
2. Using the SET VOLUME function key, set the volume for syringe A to equal the maximum volume of the syringe in the A position.
3. Set the stroke speed for syringe A to 30 seconds using the SET TIME function key.
4. Press the RUN function key.

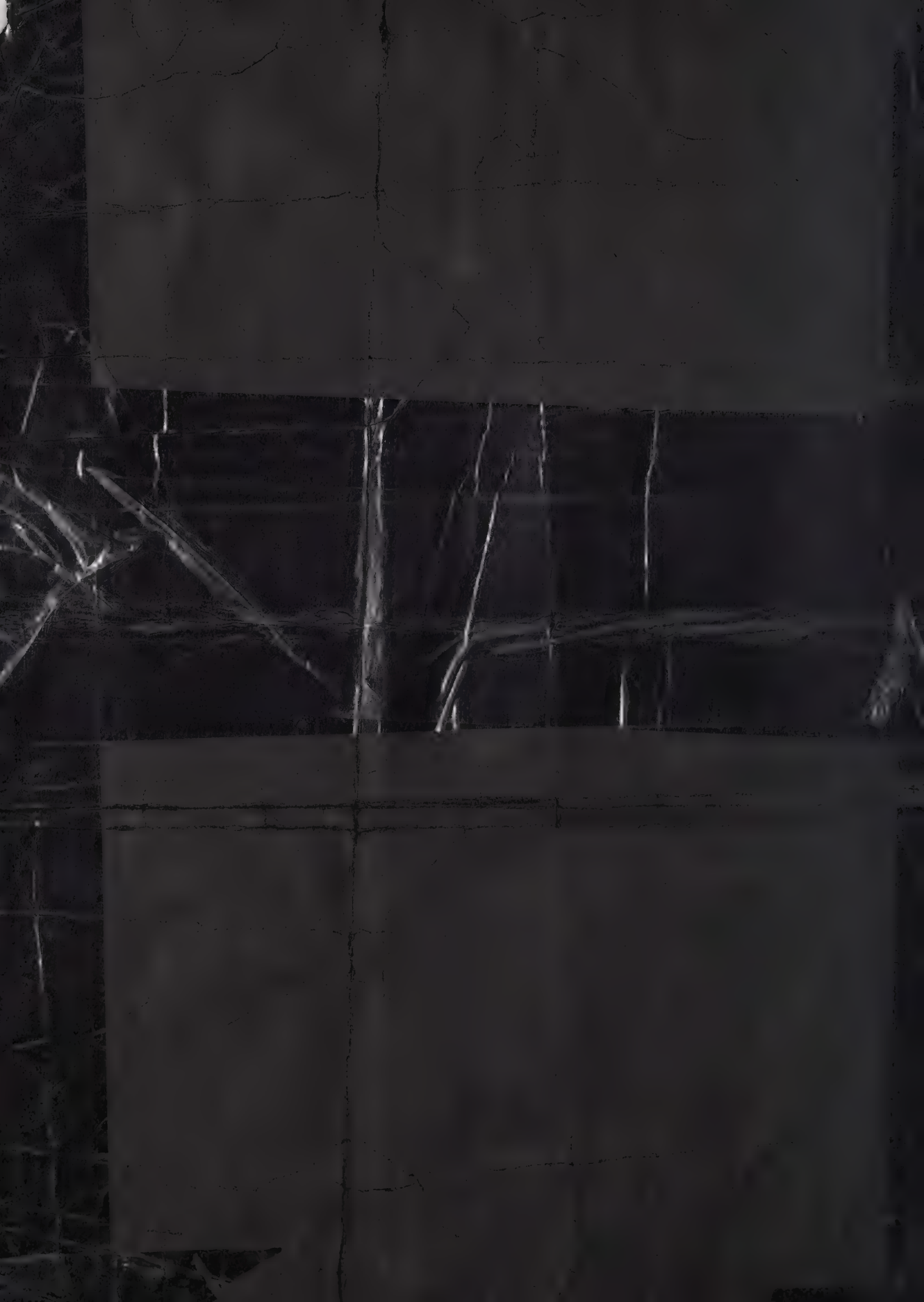
_____5. Verify that the syringe operates smoothly.

6. Set the volume for syringe A to zero.
7. Press the RUN function key.

_____8. Again, verify that the syringe operates smoothly.

_____9. Repeat steps 1–8 for syringe B and C, using the appropriate syringe volumes.





CORRECTIVE
ACTION

- **If "chattering" occurs, lubricate the syringe plunger with the solvent or liquid being used in that syringe.**

D. LEAKAGE CHECK

1. Place the inlet lines in the solvent reservoir.
2. Fill and dispense fluid through all the lines.

_____3. Verify there is no leakage at any connection.

CORRECTIVE
ACTION

- **Make sure that the fittings are "finger tight". Overtightening may damage the seal that is made at the end of the fitting with the valve.**
- **Tubing edge should be square with the fitting. It should not be cut at an angle.**
- **Verify that there are no restrictions in the flow line such as a bent cannula or pinched remote nozzle or bent tubing.**
- **Particulates trapped in the valve assembly could cause the valve to leak. Refer to the MLS Troubleshooting Guide for the Valve Cleaning procedure.**

PROCEDURE 3: VALVE OPERATION

A. SYRINGE VALVES

1. Select syringe A using the SELECT SYRINGE function key.
2. Press the SELECT VALVE SETTING function key.
3. Set any volume for syringe A by pressing the SET VOLUME function key and entering a value.
4. Press the RUN key.

_____5. Verify that an audible "CLICK" occurs when the syringe begins operating.

_____6. Repeat steps 2 through 5 for each valve.

CORRECTIVE ACTION

- **A valve containing particulate matter may not operate properly. Try flushing and cleaning the valve as described in the MLS Troubleshooting Guide.**

B. GAS VALVE

1. Select the Turntable & Gas Valve screen.
2. Manually operate the gas valve using the function key.

_____3. Verify that an audible "CLICK" occurs when this key is pressed.

CORRECTIVE ACTION

- **Refer to M91 GAS VALVE REPLACEMENT procedure.**

MASTER LABORATORY STATION
TROUBLESHOOTING GUIDE

PROCEDURE SCOPE:

The intent of this guide is to identify a faulty subassembly such as a valve, motor, or pc board in a Master Lab Station that has experienced a communication, syringe, or valve failure.

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8 inch
Screwdriver, Phillips, #1
Razor blade

Problem	Possible Cause	Corrective Action
After MLS installation or service, the Robot fails to initialize and its not possible to access any module teaching screens.	A Zymate system module may be unplugged, turned off, or operationally defective.	A. Visually check that all system modules are ON and all module-Controller connections are intact. B. If modules are on and connections intact, then: 1. Turn Controller's power OFF. 2. Unplug MLS module board. 3. Turn Controller's power ON. 4. Access the Robot teaching screen from the Bench and module setup screen. 5. If access to the Robot teaching screen is NOT possible, refer to section C. If access IS possible, refer to section D. C. If access is not possible, do the following to isolate the defective module: 1. Turn Controller OFF. 2. Remove all module boards from the Controller. 3. Plug in a single module board. 4. Turn Controller ON. 5. Verify that the module initialized by displaying its teaching screen from the Bench and module setup screen. 6. Continue steps 1-5 until the defective module is isolated. Once found, refer to the Performance Check section in the manual for that module for the appropriate action. D. If access to the Robot teaching screen is possible, then a problem exists with the MLS. Check the wire color sequence at the module-board end of the

Problem	Possible Cause	Corrective Action
		MLS communication cable. It should be (L to R): white-brown-green-red. If okay, and the communication problem still persists, contact Zymark Service for assistance.
Syringe(s) vibrate when in the zero position.	Blade switch (or microswitch on older MLS models) not adjusted	Verify the position of the switch when syringe is in the zero position.
		If the switch is not closed, then refer to M29, Manual Stop Adjustment procedure.
		If the switch appears closed and the motor continues to try to drive the syringe plunger, the switch may be defective. Refer to M19 MICROSWITCH REPLACEMENT or M20, BLADESWITCH REPLACEMENT procedure.
Valves leak	Fittings loose	Ensure that the fittings (that connect the tubing to the valves) are finger tight.
	Fitting threads stripped	Remove the fitting(s) and examine the threads for stripping. Replace if necessary.
	Tubing is cut at an angle	Remove the tubing from the fitting. Cut tubing with a sharp blade so that its end will fit flush against the fitting.
	Restriction in flow line	Verify that the tubing is free of kinks, sharp bends and pinches. Verify that cannulas are not bent. Replace or repair as required.
	Syringe speed set too fast	MLS valves are rated at 30psi. If the solvent being used is very viscous, line pressure generated during use may rise above 30 psi and cause leaks. Adjust speed accordingly.

Problem	Possible Cause	Corrective Action
Valves leak (cont.)	Particulates in the valves.	Particulates in the valves may cause sealing problems resulting in leaks. Perform the following FLUSH/CLEAN procedure: 1. Place the RESERVOIR tubes into a flask of water or other suitable solvent. 2. Select the SYRINGE > RESERVOIR setting from the MLS teaching screen. 3. FILL the syringe to maximum volume. 4. Place a waste container under the dispenser nozzle. 5. Select the SYRINGE > NOZZLE setting. 6. DISPENSE the syringes completely. 7. Repeat steps 2–6 until the flow lines are sufficiently flushed. 8. Recheck the leakage problem. If leakage persists, refer to M72, VALVE CHANGE procedure to replace valve(s).

MLS SYRINGE CHANGE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the replacement of syringes in the Master Lab Station.

PARTS (AS REQUIRED):

1.0 ml Syringe, P/N 36606
2.5 ml Syringe, P/N 36607
5.0 ml Syringe, P/N 36608
10.0 ml Syringe, P/N 36609

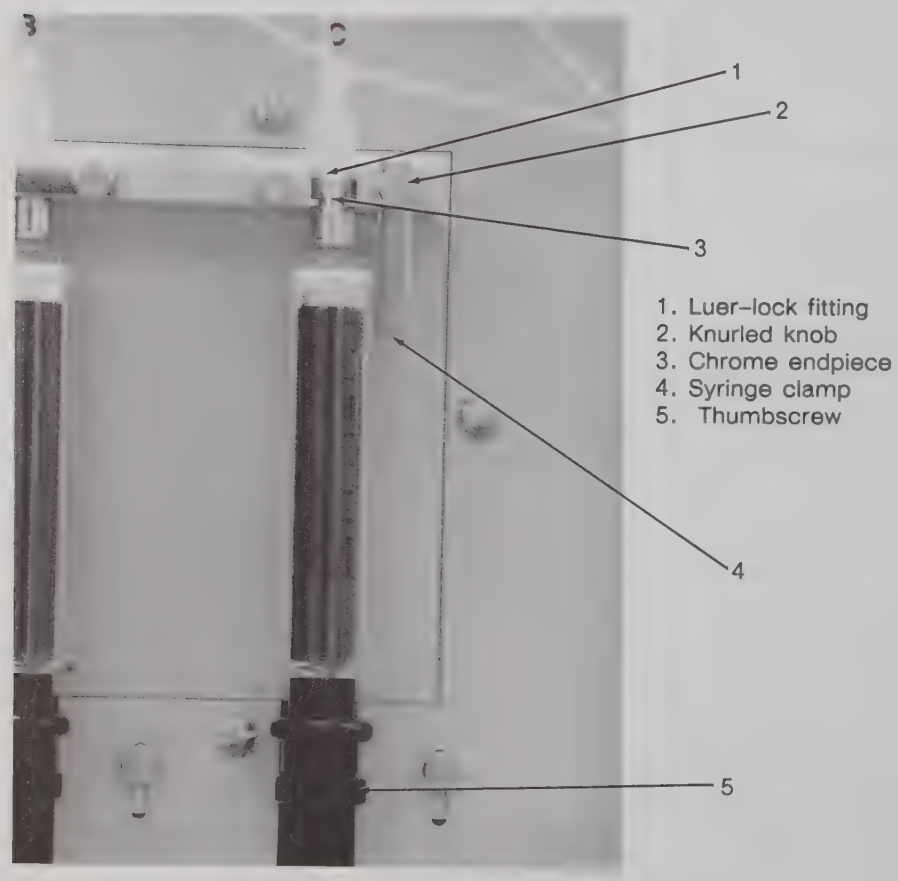
TOOLS REQUIRED:

None

PROCEDURE 1: REMOVAL

1. Loosen the knurled knob on one side of the syringe clamp. Remove the knob from the opposite side.
2. Remove the black thumbscrew from the syringe plunger.
3. Gently slide the syringe out of the housing by pulling straight out on the chrome endpiece.
4. Loosen the Luer-lock fitting between the tubing and the syringe by turning COUNTER-CLOCKWISE approximately 1/2 turn.

   This should completelty disengage the syringe from the Master Lab Station.



PROCEDURE 2: MOUNT NEW SYRINGE

1. Insert the Luer-lock fitting into the chrome endpiece of the syringe and turn the fitting CLOCKWISE until secure.
2. Align the grooves in the chrome endpiece with the tabs on the housing (make sure the syringe graduations face outward).
3. Gently push the syringe into place.
4. Position the syringe clamp across the chrome endpiece and secure it in place with the knurled knobs.
5. Gently pull the syringe plunger down until it meets the top of the driving arm.
6. Secure the plunger to the arm with the black thumbscrew previously removed.

PROCEDURE 3: OPERATIONAL CHECK

1. From the Bench and module setup screen, enter the Master Lab Station teaching screen and set the syringe size equal to that of the new syringe.
2. Run a program or manually FILL the new syringe to its maximum volume.
3. Similarly, run a program or manually DISPENSE to the zero volume.
4. Verify that there is a 1/16 to 1/8 inch gap between the top of the syringe plunger and the end of the syringe.

Refer to M29, MANUAL STOP ADJUSTMENT PROCEDURE if the gap does not meet the specifications in step 4.

MICROSWITCH REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the replacement of a defective microswitch in the Master Lab Station (early models only)*.

PARTS REQUIRED:

Switch, Micro MLS, P/N 36821

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8
Soldering iron
Solder wick

***Master Lab Stations built prior to July 1983 use microswitches to sense the stroke limits of the syringes. Master Lab Stations built after that date are equipped with a more reliable blade switch.**

PROCEDURE 1: DISASSEMBLY

A. ACCESS THE MICROSWITCH

1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF and unplug the power cord.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom rear of the station, carefully lay the cover over onto the benchtop.
5. Locate the faulty microswitch and remove the two screws securing it in place.
6. Unsolder the wires connected to the switch.

PROCEDURE 2: INSTALLATION

A. INSTALL THE NEW MICROSWITCH

1. Solder the wires onto the new microswitch.
2. Secure the microswitch in place with the two screws.

   Use the other two switches for wiring and position reference.

B. TEST MICROSWITCH OPERATION

1. Plug in the Master Lab Station's power cord and turn its power ON.
2. Turn the Controller's power ON.
3. From the Master Lab's teaching screen, select the syringe whose microswitch was replaced. Perform a complete FILL and DISPENSE.
4. Verify that the actuator arm of the microswitch is deflected by the syringe plunger driving arm when driven to zero volume.

   If the microswitch does not close, "home" will not be detected by the Master Lab Station for that syringe.
5. If necessary, adjust the microswitch placement.

C. FINALLY

1. Replace the back cover.
   a. Tilt the cover up and over the front panel.
   b. Being careful not to crimp any wires, align the cover in place on the station.
   c. Secure it in place with the seven screws.

BLADESWITCH REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure describes the steps necessary to replace a defective bladeswitch in the Master Lab Station.

PARTS REQUIRED:

Bladeswitch, P/N 37441
Cable ties

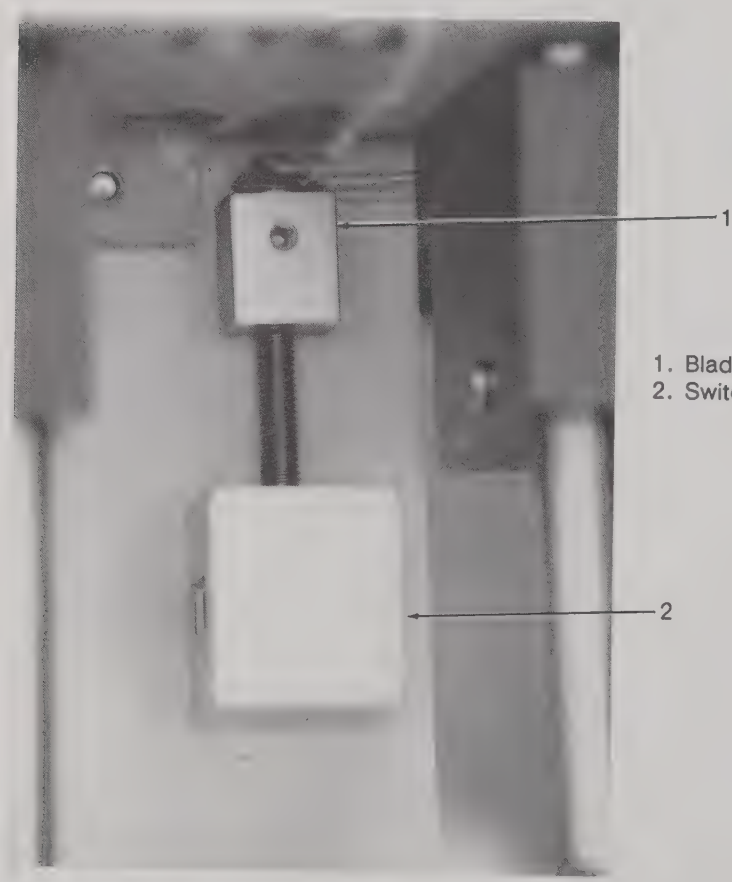
TOOLS REQUIRED:

Screwdriver, flatblade, 1/8 inch
Tape, electrical
Wire cutters

PROCEDURE 1: DISASSEMBLY

A. ACCESS THE BLADESWITCH

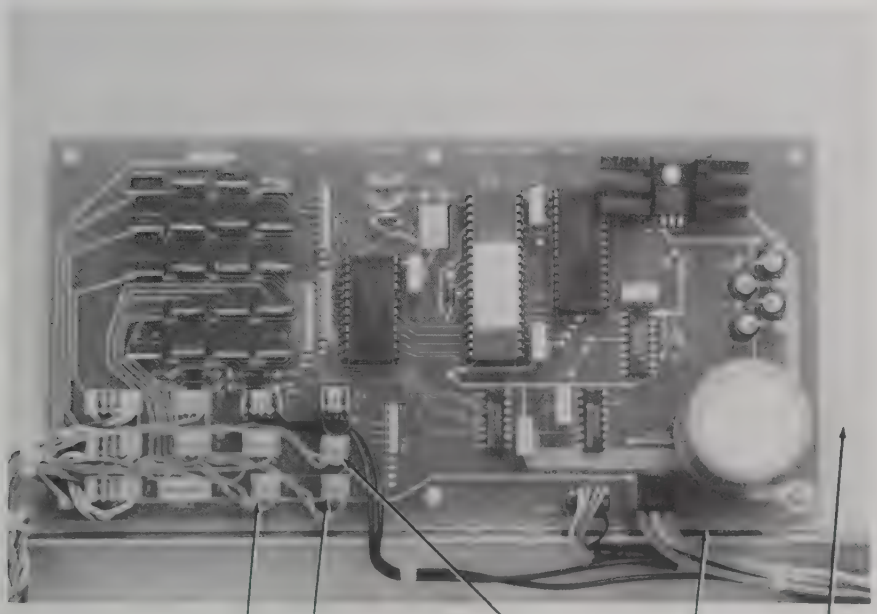
1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF and unplug the power cord.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom rear of the station, carefully lay the cover over onto the benchtop.
5. Locate the defective bladeswitch. Note that the bladeswitch positions are labelled C, B and A respectively, from left to right, when looking through the rear of the Master Lab Station.



1. Bladeswitch
2. Switch adjustment block

B. REMOVE THE BLADESWITCH

1. Locate the two screws and star washers on the front of the Master Lab Station that hold the switch adjustment block in place (for the defective bladeswitch).
2. Remove the two screws and star washers using the flatblade screwdriver.
3. Remove the switch adjustment block from the back of the Master Lab Station.
4. Unscrew and remove the knurled knob and washer on the front of the Master Lab Station that hold the bladeswitch in place.
5. Pull the bladeswitch from the rear of the Master Lab Station and cut the two wires that are connected to it. Set the switch aside.
6. Place a piece of electrical tape over the severed wire ends.
7. Locate the connector end of the severed wires on the printed circuit board. This can best be accomplished by first noting the position (A, B or C) of the defective bladeswitch and then finding its corresponding connector on the printed circuit board (labelled INA, INB or INC, respectively).
8. Once located, remove the connector from its socket on the board and cut the two wires.
9. Place a piece of electrical tape over the severed wire ends.



1. INA
2. INB
3. INC
4. PC Board
5. Back cover

PROCEDURE 2: INSTALLATION

A. INSTALL THE NEW BLADESWITCH

1. Remove the thumbwheel from the threaded rod of the defective bladeswitch and insert it onto the rod of the new bladeswitch. Position the thumbwheel so there is 1/8 to 1/4 inch of threaded rod exposed at the bottom.

2. Before placing the new bladeswitch into position, insure that the two blades are not making contact. If necessary, carefully bend the blades apart. Also, make sure the upper blade is perpendicular to the threaded rod.

3. Insert the new bladeswitch into position through the rear of the Master Lab Station and secure it in place with the knurled knob and washer previously removed. Do NOT tighten the knurled knob at this time – turn it only enough to engage the bladeswitch.

4. Plug the connector of the new bladeswitch into its socket on the printed circuit board. Run the wires of the switch parallel to the existing wire bundle and use the cable ties to secure the wires in place at various points.

5. Insert the switch adjustment block into position behind the new switch and secure it in place with the two star washers and screws previously removed.

6. Tighten the screws until snug, and then back off on each screw 1/4 turn (to loosen).

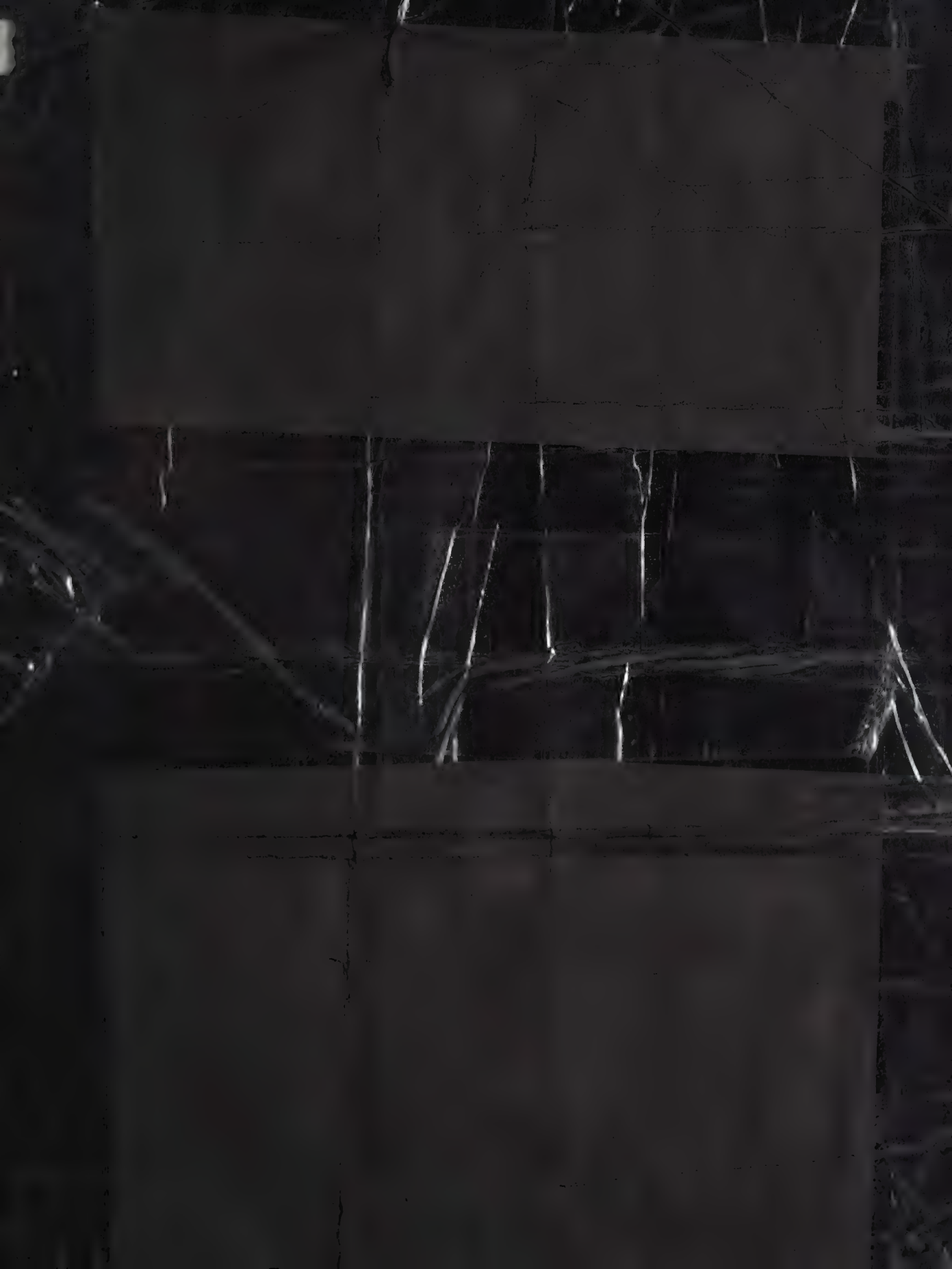
7. Pressing the switch adjustment block against the inner–front wall of the Master Lab Station, simultaneously rotate the thumbwheel completely in each direction to verify that the bladeswitch moves freely throughout its range of travel.

8. If binding is noticed, move the switch adjustment block slightly, and retry step 7.

9. Once the bladeswitch is able to freely move through its entire range of travel, alternately tighten each of the two screws and star washers in small increments while holding the adjustment block in position with your other hand.

10. After securely tightening the screws, recheck the adjustment of the bladeswitch one more time. If it is still binding, loosen the screws and retry steps 7–10.

11. Finally, adjust the height of the bladeswitch to equal that of the other two switches.



B. ADJUST THE BLADESWITCH HEIGHT

1. Plug the power cord into the Master Lab Station and turn power ON.
2. Turn the Controller's power ON.
3. Through the Master Lab Station's teaching screen, FILL the syringe (whose switch was just replaced) to maximum volume.
4. Next, DISPENSE to the zero volume.
5. If the syringe adjustment is correct, the syringe actuator arm will contact and close the bladeswitch BEFORE the syringe plunger reaches its physical stop. Adjust the height by turning the thumbwheel until a 1/8 to 1/16 inch gap exists between the top of the plunger and the end of the syringe.
6. Once adjusted, tighten the knurled knob.
7. Recheck adjustment by running a program or manually FILLING and DISPENSING the adjusted syringe.
8. Verify that the arm is not vibrating and the syringe plunger meets the requirements in step 5 above when in the zero volume position.

   For more details concerning switch adjustment, refer to M29 Manual Stop Adjustment Procedure.

C. REPLACE BACK COVER

1. Tilt the cover up and over the front panel.
2. Being careful not to crimp any wires, align the cover in place on the station.
3. Secure it in place with the seven screws.

MANUAL STOP ADJUSTMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the adjustment of the blade switches (or microswitches in older models) within the Master Lab Station. When properly adjusted, these switches provide the signal that indicates a syringe is in the zero or "home" position.

PARTS REQUIRED:

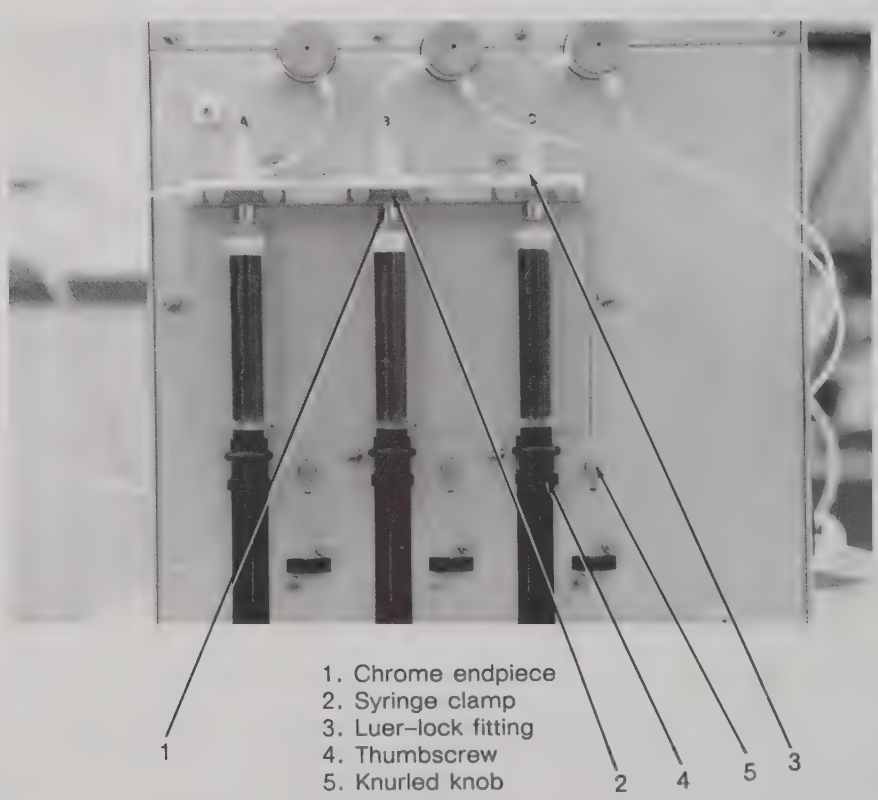
None

TOOLS REQUIRED:

None

PROCEDURE 1: PRELIMINARY

1. For Master Lab Stations using blade switches:
   a. Set the syringes to FILL to their maximum volume.
   b. Sight through the openings in the front panel (behind each syringe) and verify that the top blade of each switch is level with the benchtop.
   c. If any are not, open the rear cover and carefully bend the switch accordingly.
2. For Master Lab Stations using blade switches or microswitches:
   a. It is critical that all Master Lab Station manual stop adjustments be made so that the switch closes (reaches its "home" position) BEFORE the syringe plunger reaches it physical stop. Failure to do so causes the stepper motor to continually try to drive the plunger to its home position. This condition results in a system initialization failure.
   b. Adjust the switches so that when the home position is reached, a 1/16 to 1/8 inch gap exists between the top of the plunger and the end of the syringe.



PROCEDURE 2: ADJUST SWITCHES

1. Locate the knurled knob and the thumbwheel on the front panel of the Master Lab Station (for the switch to be adjusted). Both are located just right of the switch.
2. Loosen the knurled knob two turns.
3. Adjust the switch according to the criteria in Procedure 1 by turning the thumbwheel to the left (to raise the switch and adjust the plunger higher in the syringe), or to the right (to lower the switch and adjust the plunger lower in the syringe.
4. Once adjusted, tighten the knurled knob.
5. Check adjustment by running a program (or manually from the MLS teaching screen) to first FILL the adjusted syringes and then DISPENSE to the zero volume.
6. Verify that:
   a. None of the driving arms are vibrating (indicating a switch is incorrectly adjusted or defective).
   b. All syringe plungers come to a stop with a 1/16 to 1/8 inch gap to the end of the syringe.

STEPPER MOTOR REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the stepper motors that drive the syringes in the Master Lab Station.

PARTS REQUIRED:

Stepper Motor, P/N 36760
Cable Tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8
Wire cutters

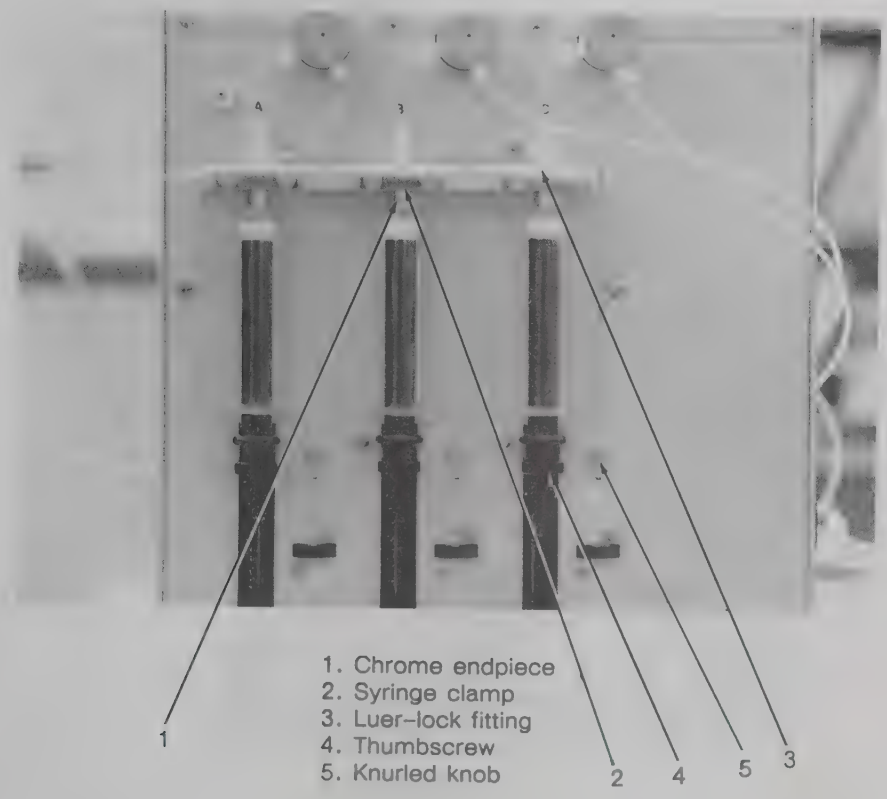
PROCEDURE 1: DISASSEMBLY

A. OPEN THE MASTER LAB STATION

1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF and unplug the power cord.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom rear of the station, carefully lay the cover over onto the benchtop.

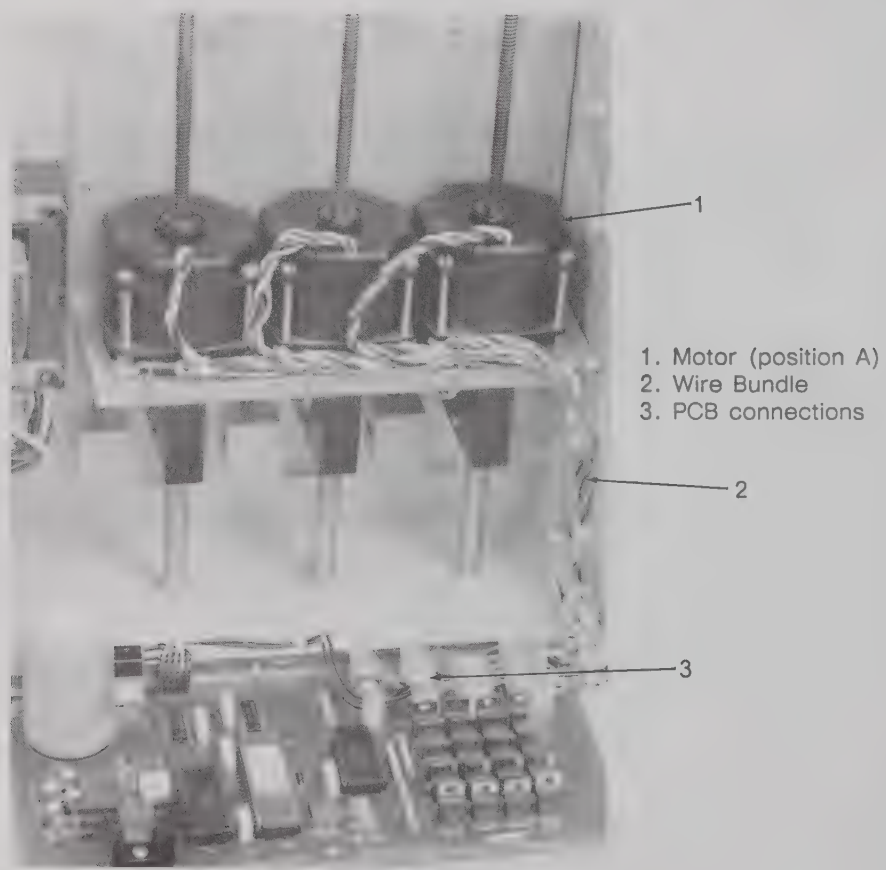
B. REMOVE ALL SYRINGES

1. Loosen the knurled knobs on one side of the syringe clamp. Remove the knob from the opposite side.
2. Remove the black thumbscrew from the syringe plunger.
3. Gently slide the syringe out of the housing by pulling straight out on the chrome endpiece.
4. Loosen the Luer-lock fitting between the tubing and the syringe by turning COUNTER-CLOCKWISE approximately 1/2 turn.
5. Repeat steps 1-4 for all three syringes.



C. DISCONNECT MOTORS

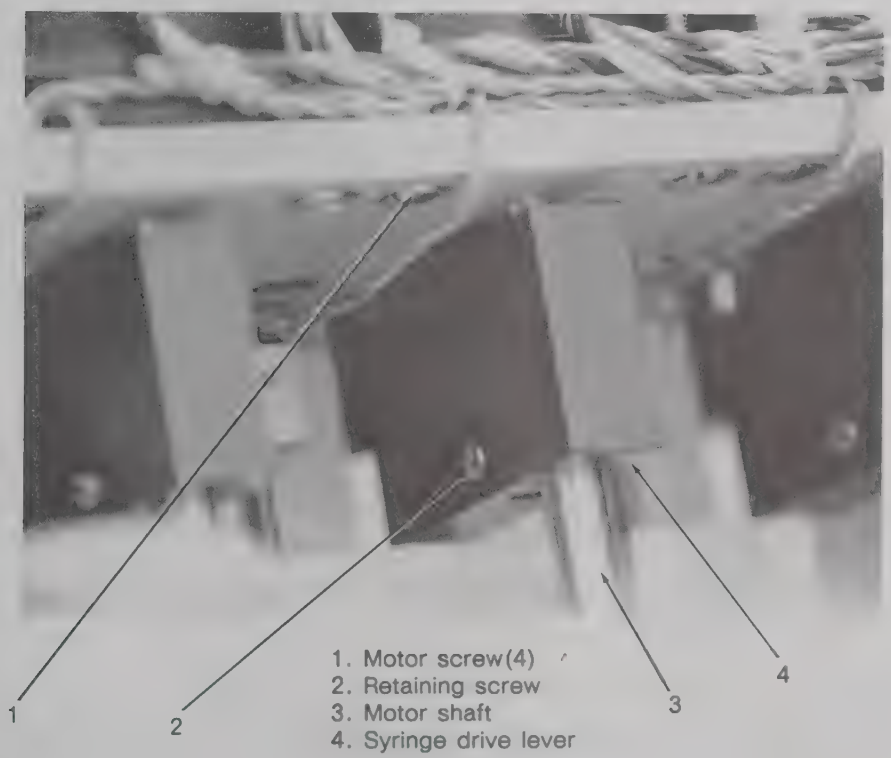
1. Locate the bundle of ty-wrapped wires inside the Master Lab Station.
2. Using the wire cutters, carefully snip the cable ties securing the wires together.
3. Follow the motor control and switch wires to the circuit board and unplug each from their respective connectors on the board.



1. Motor (position A)
2. Wire Bundle
3. PCB connections

D. REMOVE THE MOTORS

1. Using a flatblade screwdriver, remove the six screws from the front of the Master Lab Station that hold the bracket motor and lever assembly in place.
2. Carefully back out the entire assembly being careful of other wires and obstructions.
3. Locate the faulty motor and loosen the retaining screw holding the motor shaft in the syringe drive lever.
4. Using a blade screwdriver, remove the four screws securing the motor to the underside of the assembly.
5. Carefully remove the motor.



1. Motor screw(4)
2. Retaining screw
3. Motor shaft
4. Syringe drive lever

PROCEDURE 2: INSTALLATION

A. INSTALL THE MOTOR

1. Position the motor with its shaft DOWN.
2. Turn the motor shaft until the cross hole aligns with the retaining screw hole in the drive lever.
3. Slide the motor into position and secure with the four mounting screws.
4. Insert the retaining screw and tighten securely.

B. PLACE IN HOUSING

1. Carefully insert the bracket motor and lever assembly back in Master Lab Station housing.
2. Secure in place with the six screws previously removed.

C. CONNECT THE MOTOR

1. Plug all motor and switch wires into their respective connectors on the circuit board.
2. Dress the wires carefully using cable ties.

D. MOUNT THE SYRINGES

1. Insert the Luer-lock fitting into the chrome and end-piece of the syringe and turn the fitting CLOCKWISE until secure.
2. Align the grooves in the chrome endpiece with the tabs on the housing (make sure the syringe graduations face outward).
3. Gently push the syringe into place.
4. Position the syringe clamp across the chrome endpiece and secure it in place with the knurled knobs.
5. Gently pull the syringe plunger down until it meets the top surface of the driving arm.
6. Secure the plunger to the arm with the black thumbscrew previously removed.
7. Repeat steps 1-6 for each syringe.

E. REASSEMBLE MASTER LAB STATION

1. Replace back cover.
   a. Tilt the cover up and over the front panel.
   b. Being careful not to crimp any wires, align the cover in place on the station.
   c. Secure it in place with the seven screws.
2. Plug the power cord into the Master Lab Station.

PROCEDURE 3: VERIFY OPERATION

1. Turn the Master Lab Station and Controller power ON.
2. Go through the Master Lab Station Performance Check procedure for the syringe(s) whose motor(s) required replacement.

PRINTED CIRCUIT BOARD REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and replacement of the Master Lab Station's printed circuit board.

PARTS REQUIRED:

MLS PC Board, P/N 36171

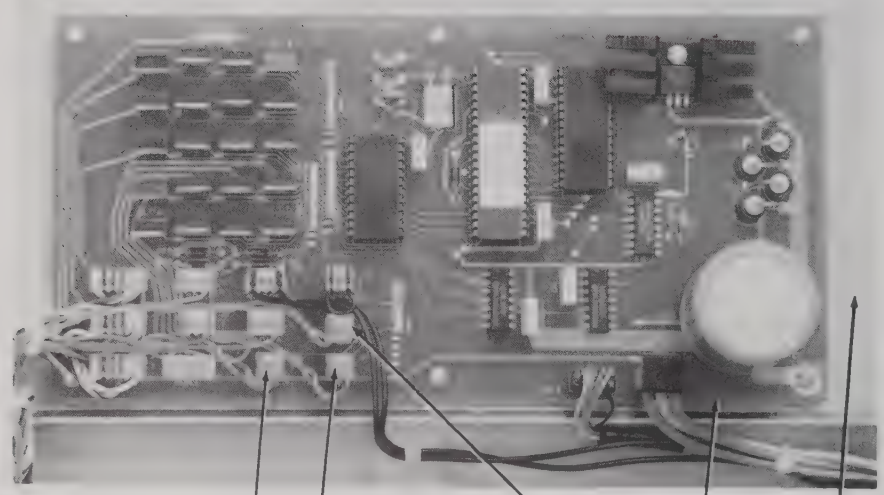
TOOLS REQUIRED:

Screwdriver, flatblade, 1/8, 3/16
Masking tape

PROCEDURE 1: REMOVAL

A. ACCESS THE PRINTED CIRCUIT BOARD

1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF and disconnect the power cord.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom rear of the station, carefully lay the cover over onto the benchtop.



1. INA
2. INB
3. INC
4. PC Board
5. Back cover

B. LABEL ALL CONNECTORS

1. Label all connectors to the board.
   a. There are 12 connectors if the turntable is not used.
   b. There are 14 connectors if the turntable is used.
2. Unplug all connectors from board.

C. REMOVE BOARD

1. Using a flatblade screwdriver, remove the six screws securing the board in place.
2. Remove the board and set aside.

PROCEDURE 2: INSTALLATION

A. INSTALL THE NEW PC BOARD

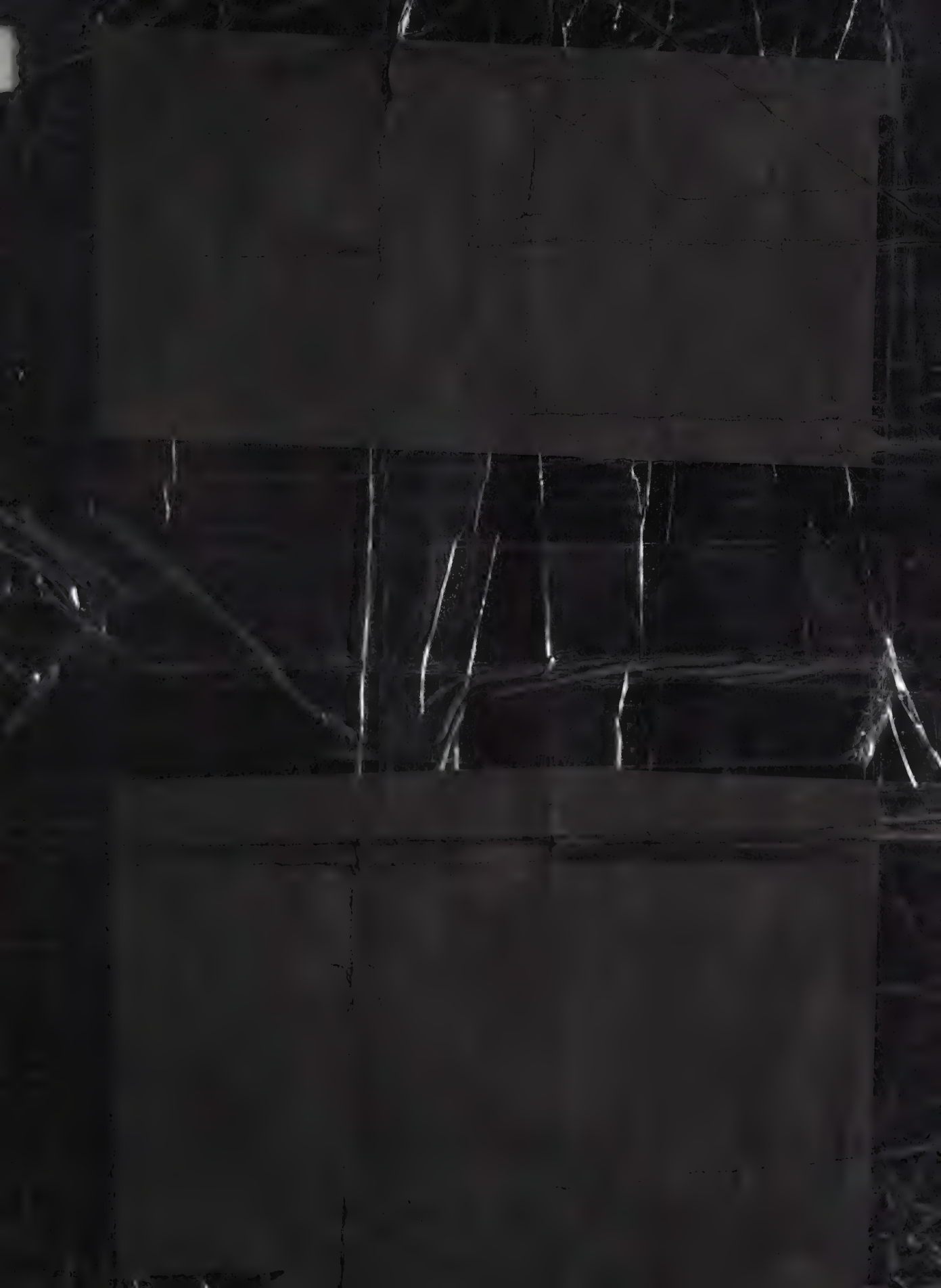
1. Secure the board in place with the six screws.

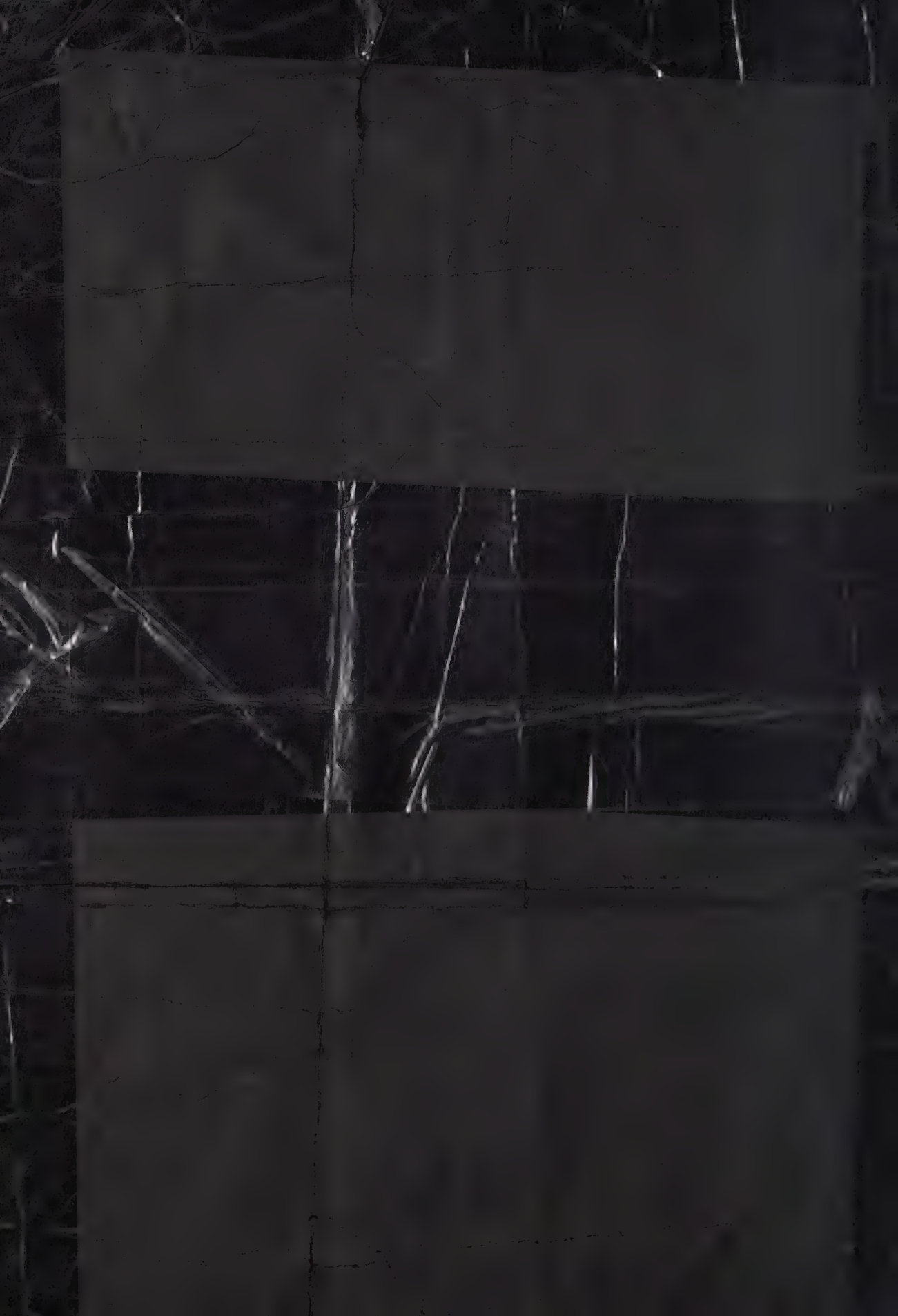
B. PLUG IN CONNECTORS AS LABELLED

1. Verify they are fully seated on the board.

C. REPLACE REAR COVER ON MASTER LAB STATION

1. Tilt cover up and over front panel.
2. Being careful not to crimp any wires, align the cover in place on the station.
3. Secure it in place with the seven screws.





PROCEDURE 3: VERIFY OPERATION

1. Plug the power cord into the Master Lab Station.
2. Turn the Master Lab Station and Controller power ON.
3. Go through the Master Lab Station Performance Check procedure to verify that the new printed circuit board operates correctly.

VALVE CHANGE PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the removal and installation of the solenoid valves on the Master Lab Station.

PARTS REQUIRED:

3-way Valve Assembly, P/N 36761
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8"
Wire cutters

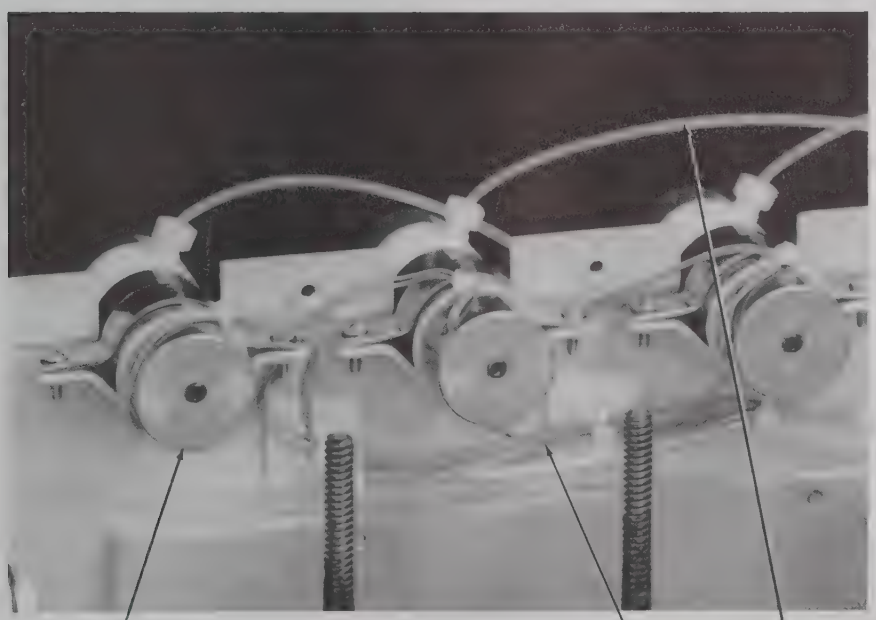
PROCEDURE 1: DISASSEMBLY

A. OPEN THE MASTER LAB STATION

1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the back cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom rear of the station, carefully lay the cover over onto the benchtop.

B. REMOVE THE VALVE

1. Locate the valve to be replaced.
2. Remove any fluid lines attached to the valve.
3. Using the wires cutters, carefully snip the cable ties securing the valve wires together.
4. Follow the wire leads from the valve to the circuit board and unplug its connector from the board.
5. Using a flatblade screwdriver, remove the two valve bracket screws securing the valve to the Master Lab Station.
6. Remove the bracket and valve.



1. Three-way valve(3)
2. Wires
3. Fluid line

PROCEDURE 2: INSTALLATION

A. POSITION THE VALVE

1. Position the new valve in place and orient it to match the other valves.
2. Place the bracket over the valve and secure with the two screws.
3. Plug the connector into the circuit board.
4. Install cable ties around the wires leading to the board.

B. REASSEMBLE MASTER LAB STATION

1. Replace the back cover.
   a. Tilt the cover up and over the front panel.
   b. Being careful not to crimp any wires, align the cover in place on the station.
   c. Secure it in place with the seven screws.
2. Plug the power cord into the Master Lab Station.

PROCEDURE 3: VERIFY OPERATION

1. Turn the Master Lab Station and Controller power ON.
2. Go through the Master Lab Station Performance Check procedure to verify correct operation for the valve just installed.

TURNTABLE INSTALLATION PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the installation of the optional turntable accessory for the Master Lab Station.

PARTS REQUIRED:

Z520 Fraction Collector Station
Cable tie, 4", P/N 36740

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8"

PROCEDURE 1: PREPARATION

A. OPEN THE MASTER LAB STATION

1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF and unplug the power cord.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the back cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom–rear of the station, carefully lay the cover over onto the benchtop.

B. REMOVE THE PLATE

1. Locate the plate covering the turntable connector opening on the side of the Master Lab Station.
2. Remove the four screws and nuts securing the plate in place.
3. Place these screws and nuts aside for future use.

C. REMOVE JUMPER

1. Locate connector J14 on the Master Lab Station circuit board.
2. Remove the jumper.
3. Secure this jumper to any of the lead wires for future use.

   This jumper grounds connector J14 when the turntable accessory is not installed, permitting the Master Lab Station to initialize.

PROCEDURE 2: INSTALLATION

A. INSTALL THE TURNTABLE CABLE

1. Feed the free end of the turntable cable through the opening in the side of the Master Lab Station.
2. Secure the threaded connector in place with the four screws and nuts previously removed.
3. Plug the six-pin connector into J14 on the circuit board.

B. REINSTALL THE BACK COVER

1. Tilt the cover up and over the front panel.
2. Being careful not to crimp any wires, align the cover in place on the station.
3. Secure it in place with the seven screws.

C. ADD THE TURNTABLE

1. Plug the cable attached to the turntable into the connector just installed.
2. Securely screw the connector in place.

D. VERIFY OPERATION

1. Refer to section 4.0 in the Master Lab Station's User's Guide for turntable operating instructions.

GAS VALVE REPLACEMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure describes the steps necessary to replace the gas valve in the Master Lab Station.

PARTS REQUIRED:

Gas valve, P/N 36762
Cable ties

TOOLS REQUIRED:

Screwdriver, flatblade, 1/4
Wire cutters
Razor blade

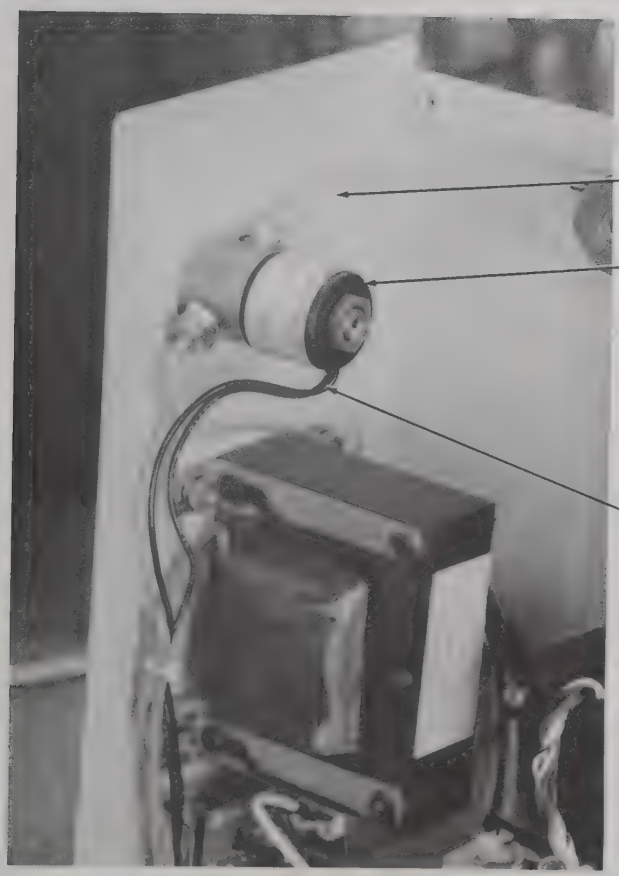
PROCEDURE 1: REMOVE GAS VALVE

A. ACCESS THE VALVE

1. Turn the Controller's power OFF.
2. Turn the Master Lab Station's power OFF and disconnect the power cord.
3. Turn OFF the gas supply to the Master Lab Station.
3. Using a flatblade screwdriver, remove the seven screws holding the back cover of the Master Lab Station in place.
4. Gently lift the cover up enough to clear the top of the Master Lab Station. Pivoting from the bottom rear of the station, carefully lay the cover over onto the benchtop.

B. REMOVE GAS VALVE

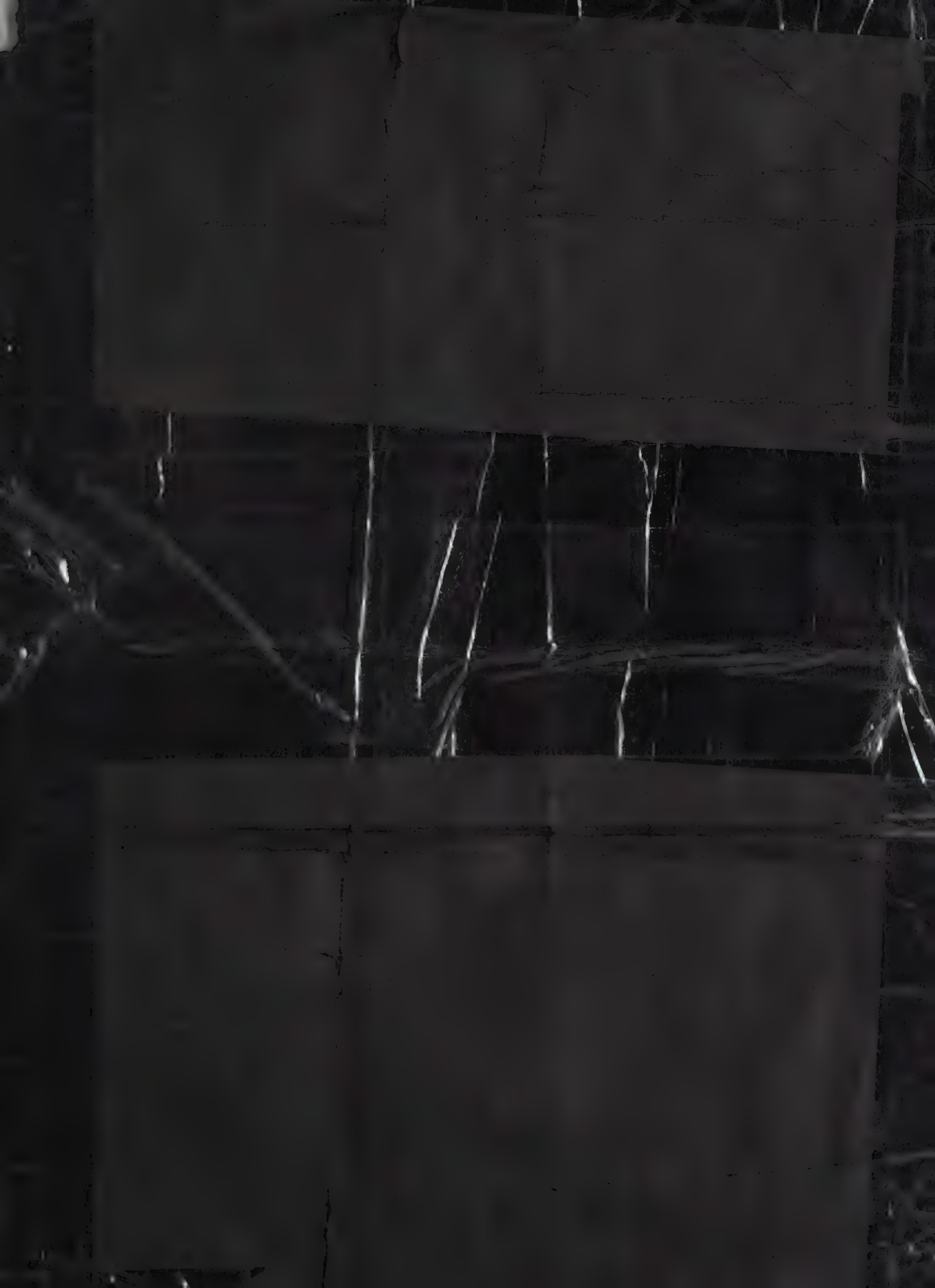
1. Cut the two sections of clear tubing that connect to the valve. Make sure the cuts are as close as possible to the valve fittings. Remove the tubing endpieces from the valve.
2. Carefully cut the cable-ties that secure the wires leading from the valve to the printed circuit board. Unplug the connector from its socket on the board.
3. Using the screwdriver, remove the two screws and star washers that hold the gas valve in place.
4. Remove the valve and set aside the screws and star washers for later use.

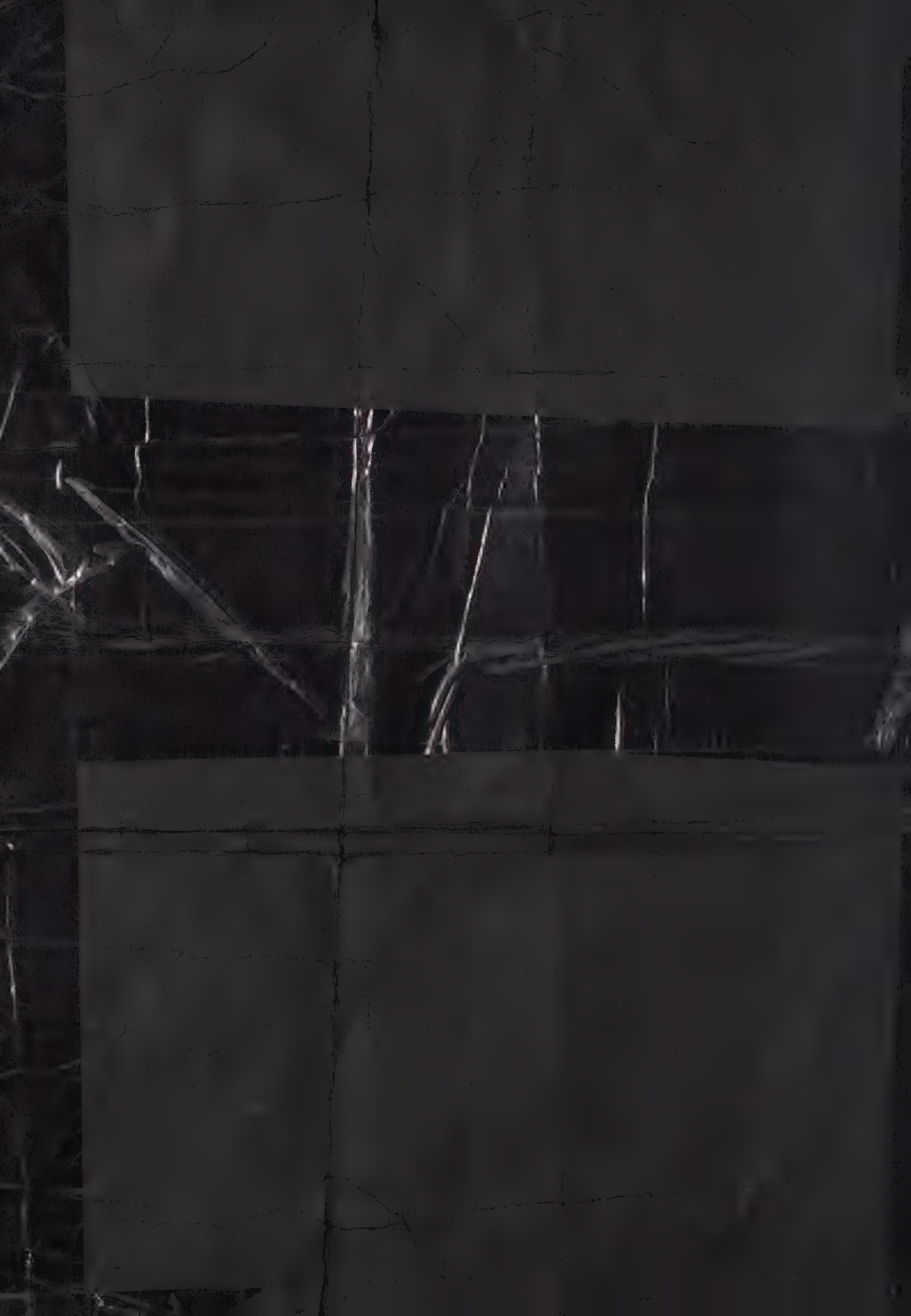


1. Clear tubing
2. Gas valve
3. Wires

PROCEDURE 2: INSTALL NEW GAS VALVE

1. Use the razor blade to trim approximately 1/8 inch of tubing from the free end of each tube cut from the gas valve in step B1. Make sure the cut is SQUARE, not angled.
2. Position the new valve within the Master Lab Station (with the wires pointing down) and secure it in place with the star washers and screws previously removed.
3. Push each end of the tubes onto the appropriate gas valve fitting, making sure the tubes fit flush with the back of each fitting.
4. Cable-tie the wires together, being careful not to pinch the tubing.





PROCEDURE 3: VERIFY OPERATION

1. Plug the power cord into the Master Lab Station.
2. Turn the Master Lab Station and Controller power ON.
3. Access the Turntable and Gas Valve teaching screen.
4. Manually toggle the gas valve function key ON and OFF and verify operation by listening for an audible "click" when the key is pressed.

M88

MASTER LAB STATION
SPECIFICATIONS

A. Performance

Repeatability:	0.5% of syringe volume when dispensing 20% or greater of syringe volume

B. Syringes

Hamilton Series 1000 and 1700 (1ml to 10ml)

Stroke:	910 steps (full stroke)
Mechanism Lash:	1% full draw

C. Valves

Syringe (3-way):	to 30 psi
Gas:	to 100 psi

D. Physical

Size:	Height	12.1 inches
	Depth	5.0 inches
	Width	11.5 inches
Weight:	22 lbs	

E. Power

Voltage:	100, 120, 220, 240 VAC ± 10%
Frequency:	47–63 Hz
Power Consumption:	.37 amps (full load – 3 syringes)

To meet specifications:

1. Select syringe size so that the smallest amount to be dispensed is 20% of the syringe capacity.
2. Use a minimum dispensing time of 10 seconds for any syringe at full stroke. Maximum dispensing time (at full stroke) should not exceed 20 seconds.
3. De-gas solvents. (Refer to MLS Users Guide for details)

Zymark

ZYMATE SYSTEM
SERVICE MANUAL

VOLUME 2

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Zymark Corporation

P/N 41906

McBEE

Power & Event Controller

Section 1: Theory of Operation

Power & Event Controller Theory of Operation

Section 2: Performance

Power & Event Controller Performance Check

Section 3: Repair/Replacement

P11 Power Source Adjustment Procedure
P60 Printed Circuit Board Removal, PEC

Section 4: Specifications

Power & Event Controller Specifications

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EXTERNAL POWER			
Check	8		
Adjustment		P11	✓
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Replacement		P60	
PERFORMANCE			
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Sensed Input	4		
A/D Input	5		
AC Outlet	6		
Variable AC Outlet	7		
External Power Source	8		

POWER AND EVENT CONTROLLER THEORY OF OPERATION

The Power & Event Control module performs a variety of functions which allow the user to interface with devices not under the direct control of the Zymate System. The Power & Event Controller provides the following interfaces:

8 relay switch closures

8 sensed inputs

1 A/D converter input (analog to digital)

+5V, +12V and -12V power sources

2 switched AC outlets

1 variable AC outlet

Relay Switch Closures

Relay switch closures provide the ability to activate or signal external devices such as solenoid valves, larger capacity relays, other analytical instruments, etc. These devices are operated using module commands to control the relay switch state during the running of an EasyLab program.

Sensed Inputs

Sensed inputs provide the ability to detect the presence or absence of a signal (ground or +5V). The state at any of these inputs can be accessed using module commands during the running of an EasyLab program.

A/D Converter Input

The A/D converter input can read an analog signal in the range from 0 to 2V DC. (This analog signal may come from external devices such as pH meters, temperature probes, etc.) This analog reading is converted to digital counts which range between 0 and 2000.

This input can be further scaled to units consistent with the device being used for user-interpretation and control during the running of an EasyLab program.

Power Sources

Devices operated using the relay switch closures may require power for activation. Power may be provided using the +5V, +12V or -12V power sources on the front panel of the Power & Event Controller. However, care should be taken NOT TO EXCEED THE CURRENT CAPABILITIES of the Power & Event Controller. Consult the specifications for the Power & Event Controller provided at the end of this chapter of the Zymate Service Manual and the specifications provided with the device to be used to verify that the current drawn is within the limits stated. If limits are exceeded, damage may occur.

AC Power

AC power to devices such as vortexers, heating plates, etc. may be switched on or off using either of two switched outlets on the rear panel of the Power & Event Controller. This action can be controlled using module commands that represent ON or OFF states for that outlet during the running of an EasyLab program.

Variable AC Power

Variable AC power to external devices such as motors, lamps, etc. can be provided using the variable AC outlet on the rear panel of the Power & Event Controller. The amount of AC voltage at the outlet can be controlled using a module command that is set equal to a numeric value representative of the desired voltage value during the running of an EasyLab program. A one-to-one correspondence between the numeric value and the AC voltage does not exist. Response will be device specific.

Spare Connectors

Spare connectors bring out connections to internal options of the Power & Event Controller. For example, installation of the Preamplifier Module option requires the use of these spare connectors. The connectors may also be used as physical mounting points ("tie points") if no option is installed.

POWER & EVENT CONTROLLER PERFORMANCE CHECK

PROCEDURE SCOPE:

The following performance check procedures are used to verify that the Power & Event Control module IS or IS NOT functioning properly. This performance check verifies:

1. Communication between the Zymate Controller and the Power & Event Control Module
2. External Switch Operation
3. Input Signal Sensing
4. A/D Input Operation
5. A/C Outlet Operation
6. Variable AC Outlet Operation
7. External Power Source

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Procedures for the replacement of parts are provided as well as in-depth troubleshooting information in this chapter of the Zymark Service Manual.

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8"
Digital voltmeter (DVM)
Plug-in Bulb Socket
Light Bulb (100 watts or greater)
Wire 6"
Power supply (0 – 2V output)

PROCEDURE 1: VERIFY COMMUNICATION BETWEEN CONTROLLER & PEC

1. Turn the Controller's power OFF.
2. Plug the PEC module card into the support board on the Controller.
3. Connect the communications cable and power cord.
4. Turn the PEC power ON.
5. Turn the Controller's power ON.

_____a. Wait for the Robot to initialize.

Confirm Robot initialization by successfully entering and leaving the Robot teaching screen.

CORRECTIVE ACTION

The Robot may fail to initialize if any system module is unplugged, turned off or operationally defective. Troubleshoot to find which module is defective by removing modules from the system in some sequence until the defective module is isolated.

To isolate the module:
1. **Turn the Controller's power OFF.**
2. **Remove all module cards from the Controller.**
3. **Plug in a single Zymate module card.**
4. **Turn the Controller's power ON.**
5. **Verify that the module initialized by displaying its teaching screen found under Bench and module setup.**
6. **Repeat 1–5 above for each module.**

WHEN THE DEFECTIVE MODULE HAS BEEN ISOLATED, REFER TO THE PERFORMANCE CHECK SECTION IN THE MANUAL FOR THAT MODULE FOR THE APPROPRIATE ACTION.

_____b. Select the Bench and module screen and verify that the PEC is listed.

CORRECTIVE ACTION

If the PEC is not listed as a module on the Bench and module setup screen, the module card, communication cable or module support board may be installed incorrectly or be defective.

1. **Make sure that all boards are firmly seated in their respective connectors.**
2. **Try alternate connectors.**
3. **If all else fails, replace the module card for the PEC.**

PROCEDURE 2: VERIFY EACH EXTERNAL OUTPUT IS FUNCTIONAL

1. Disconnect any connections to the external output terminals on the Power & Event Controller.
2. Press the OUTPUT CONTROL function key on the Power & Event Controller setup screen.
3. Press SELECTOR UP/SELECTOR DN to move the switch selection bar to the switch to be tested.
4. Press the ON function key.
5. Set the DVM leads to each side of the switch to be tested.
6. Touch the DVM leads to each side of the switch to be tested.
7. Press the EXECUTE LINE function key.

_____ 8. Verify that DVM reads 0 ohms.

9. While holding the DVM leads on the switch, press the OFF function key.
10. Press the EXECUTE LINE function key.

_____ 11. Verify that DVM reads INFINITY (non-zero).

12. Repeat steps 3 through 11 for each switch.

CORRECTIVE ACTION

- **If any of the switches fail, replace the printed circuit board. Refer to P60 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

PROCEDURE 3: VERIFY EACH INPUT SENSES A SIGNAL

1. Disconnect all connections to the input terminals on the Power & Event Controller.
2. Press the INPUT CONTROL function key on the Power & Event Controller menu screen.

_____3. Verify that each input reads HIGH.

CORRECTIVE ACTION

- **Make sure that all connections to the input terminals have been removed.**
- **If any INPUT reads LOW (with no connections to it), the printed circuit board should be replaced. Refer to P60 – PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

4. Connect a wire to one of the GROUND pins on the Power & Event Controller.
5. Touch the opposite end of the wire to one of the inputs.

_____6. Verify that the input status reads LOW.

7. Repeat steps 5 and 6 for each input.

CORRECTIVE ACTION

- **If any one of the inputs fail to read LOW when it is grounded, the printed circuit board should be replaced. Refer to P60 – PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

PROCEDURE 4: VERIFY THE A/D INPUT SIGNAL

> **CAUTION: During the testing of the A/D input, keep the output of the power supply within the 0 to 2V range to prevent damage to the Power & Event Controller.**

1. Attach the ground lead of the power supply to one of the GROUND pins on the Power & Event Controller.
2. Connect the other lead of the power supply to the A/D INPUT pin on the Power & Event Controller.
3. Press the A/D CONTROL function key on the Power & Event Controller menu page.
4. Adjust the power supply to 0 volts.

_____5. Verify that the A/D input value displayed on the screen is very low or blank.

6. Increase the power slowly to +2V.

_____7. Verify that the A/D input value displayed on the screen changes linearly up to a maximum value of approximately 2000.

CORRECTIVE ACTION

- **Recheck the connections. If the A/D does not respond, replace the printed circuit board. Refer to P60 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

PROCEDURE 5: VERIFY AC OUTLET OPERATION

1. Screw the light bulb into the plug-in bulb socket.
2. Insert the bulb and socket into the AC outlet to be tested at the rear of the Power & Event Controller.
3. Press the AC CONTROL function key on the Power & Event Controller menu page.
4. Move the outlet selection bar to the outlet to be tested using the appropriate function key.
5. Press the ON/OFF function key until the status display reads ON.
6. Press the EXECUTE LINE function key.

_____7. Verify that the light bulb illuminates.

CORRECTIVE ACTION

- **Make sure that the bulb is plugged into the outlet being programmed.**
- **Verify that the bulb has not burned out.**

8. Press the ON/OFF function key until the status display reads OFF.
9. Press the EXECUTE LINE function key.

_____10. Verify that the light goes out.

11. Repeat steps 2, 4 through 10 to test the other outlet.

CORRECTIVE ACTION

- **If neither outlet responds, replace the printed circuit board. Refer to P60 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

PROCEDURE 6: VERIFY THAT THERE IS VARIABLE AC CONTROL

1. Insert the bulb and socket into the VARIABLE AC outlet on the rear panel of the Power & Event Controller.
2. Press the VARIABLE AC CONTROL function key on the Power & Event Controller menu page.
3. Hold the INCREASE VOLTAGE function key in until the maximum output value of 200 is reached.

_____4. Verify that the intensity of the light from the bulb increases gradually during this time.

CORRECTIVE ACTION

- **Make sure that the bulb is plugged into the correct outlet.**
- **Verify that the bulb has not burned out.**

5. Hold the DECREASE VOLTAGE function key in until the minimum output value of 0 (MIN.) is reached.

_____6. Verify that the intensity of the light from the bulb decreases gradually during this time.

CORRECTIVE ACTION

- **If the outlet does not respond, replace the pc board. Refer to P60 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

PROCEDURE 7: VERIFY THE EXTERNAL POWER SOURCES

1. Set the DVM to a 20V scale.
2. Holding the black lead to one of the GROUND pins, touch the RED lead to the +5V terminal.

_____3. Verify that the value displayed is approximately 5VDC.

CORRECTIVE ACTION

- **Replace the pc board. Refer to P60 PRINTED CIRCUIT BOARD REPLACEMENT for detailed instruction.**

4. Holding the black lead to one of the GROUND pins, touch the RED lead to the +12V terminal.

_____5. Verify that the value displayed is approximately 12VDC.

6. Holding the red lead to one of the GROUND pins, touch the black lead to the -12V terminal.

_____7. Verify that the value displayed is approximately 12VDC.

CORRECTIVE ACTION

- **The +12V and -12V power sources can be adjusted by turning the pots on the rear panel. (These pots can be adjusted between 3 and 15 V.) Refer to P11 12V POWER SUPPLY ADJUSTMENT for more detailed instruction.**

POWER SOURCE ADJUSTMENT PROCEDURE

PROCEDURE SCOPE:

This service procedure covers the adjustment of the +12V/–12V external power sources on the Power & Event Controller.

PARTS REQUIRED:

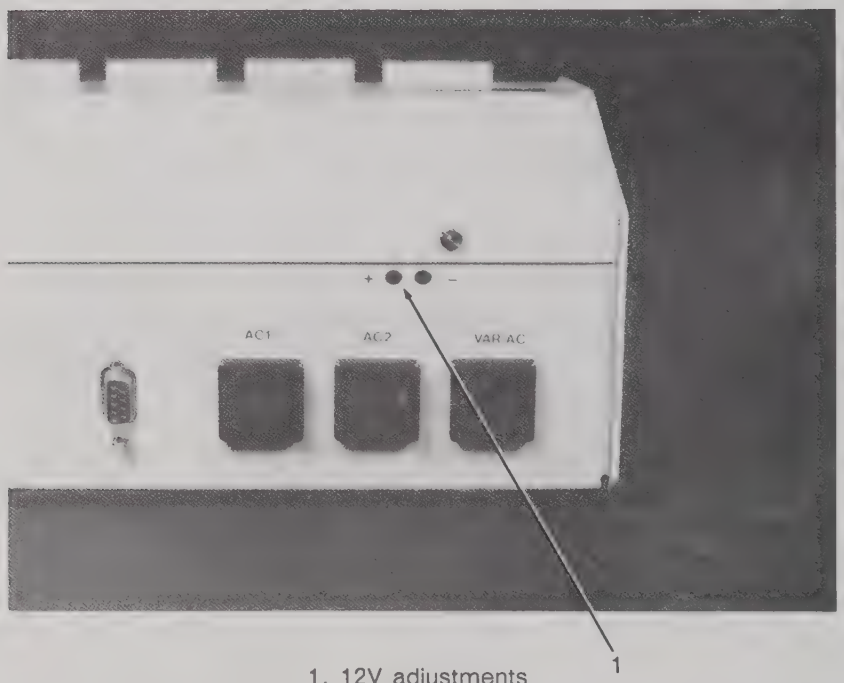
None

TOOLS REQUIRED:

Screwdriver, flatblade, 1/8"
Digital Voltmeter (DVM)

PROCEDURE: ADJUSTMENT

1. Turn the Zymate System's power ON.
2. Set the DVM to the 20V DC scale.
3. Hold the common lead to GROUND.
4. Touch the other lead to the +12V pin on the Power & Event Controller.
5. Using a small flatblade screwdriver, turn the power supply adjustment on the rear panel on the Power & Event Controller until the desired voltage reading is obtained on the DVM.
6. Follow the above steps to adjust the -12V power source.



1. 12V adjustments

PRINTED CIRCUIT BOARD PROCEDURE, PEC

PROCEDURE SCOPE:

This service procedure covers the removal and replacement of the Power & Event Controller's printed circuit board.

PARTS REQUIRED:

PEC PC Board, P/N 36479

TOOLS REQUIRED:

Screwdriver, flatblade
Wrench, open box-end, 5/16

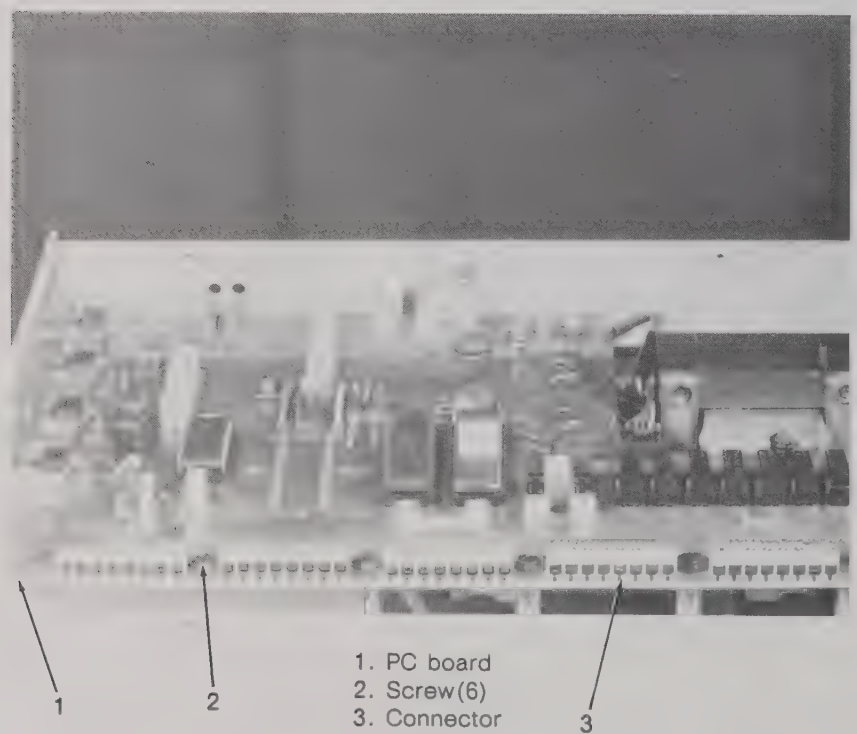
PROCEDURE 1: REMOVAL

A. ACCESS THE PRINTED CIRCUIT BOARD

1. Turn the Controller's power OFF.
2. Turn the Power & Event Controller's power OFF and disconnect the power cord.
3. Disconnect any devices attached to the Power & Event Controller.
4. Using a flatblade screwdriver, remove the four screws holding the cover of the Power & Event Controller in place.
5. Lift the cover up and off the module to expose the printed circuit board.

B. LABEL ALL CONNECTIONS

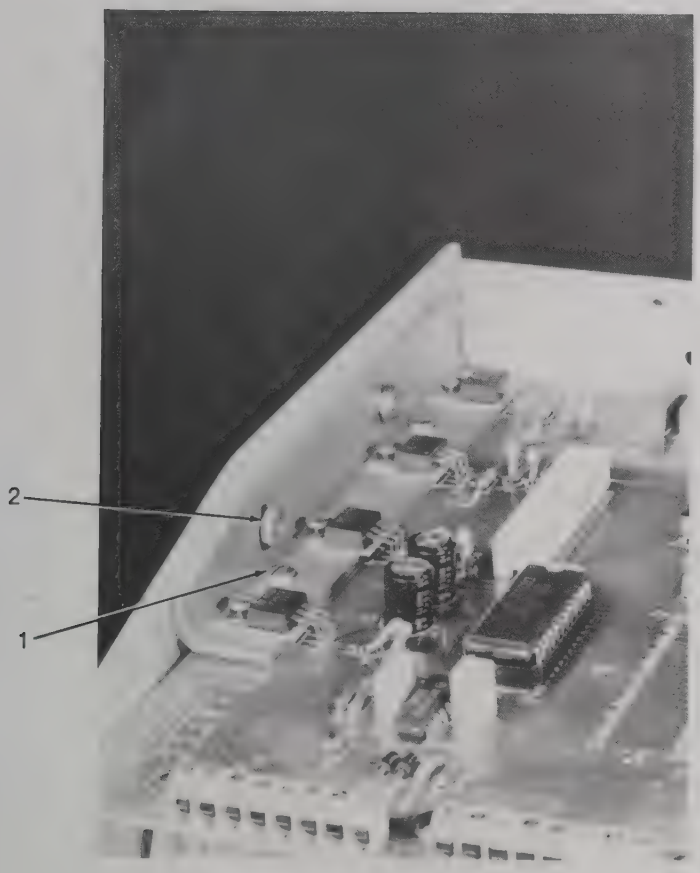
1. Label all connectors to the board.
2. Unplug all connectors from board.



1. PC board
2. Screw(6)
3. Connector

C. REMOVE BOARD

1. Using a flatblade screwdriver, remove the nine screws securing the board in place.
2. Remove the nuts holding the grounding plate in place.
3. Remove the board and set aside.



1. Nut(2)
2. Grounding plate

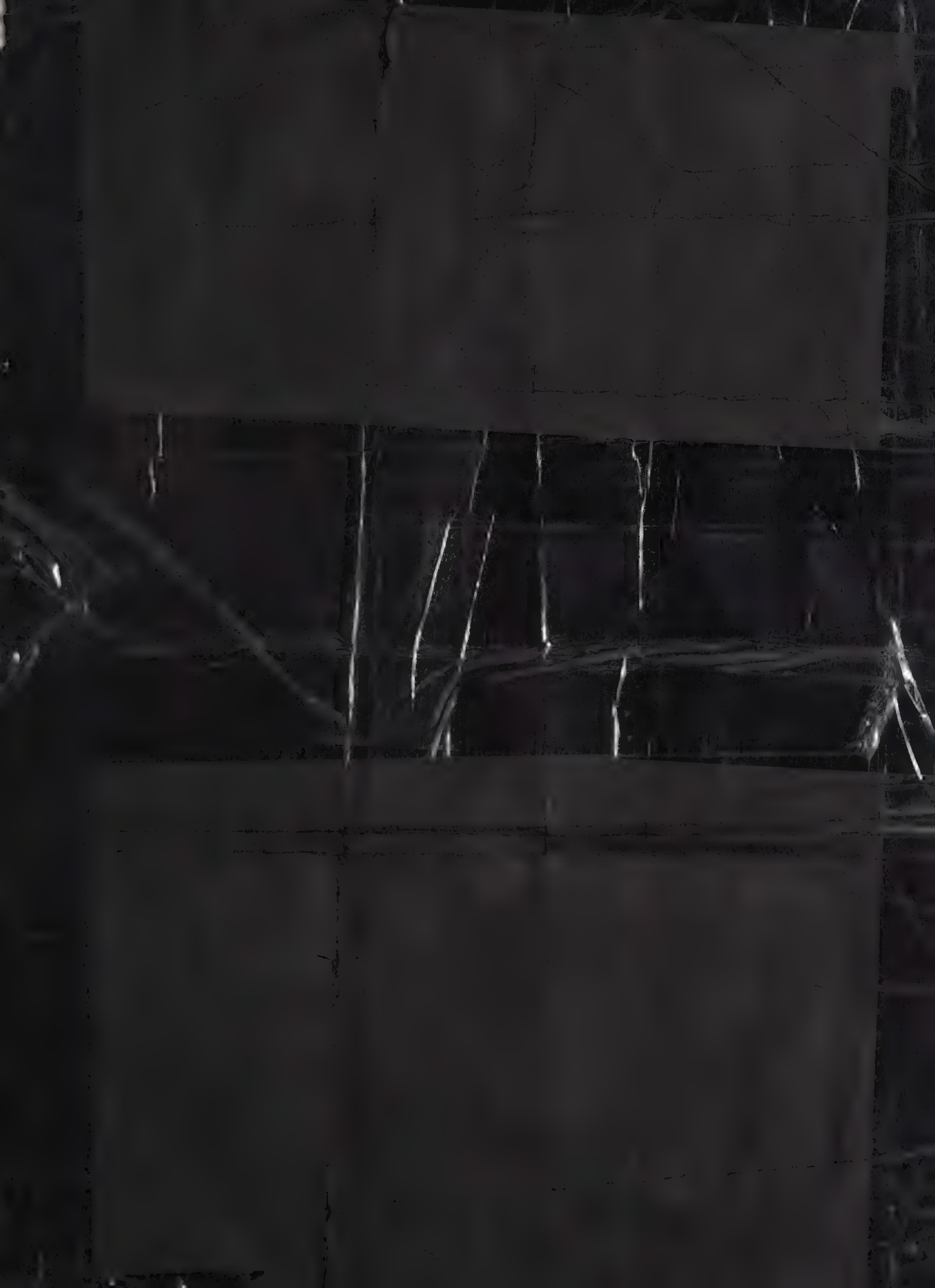
PROCEDURE 2: INSTALLATION

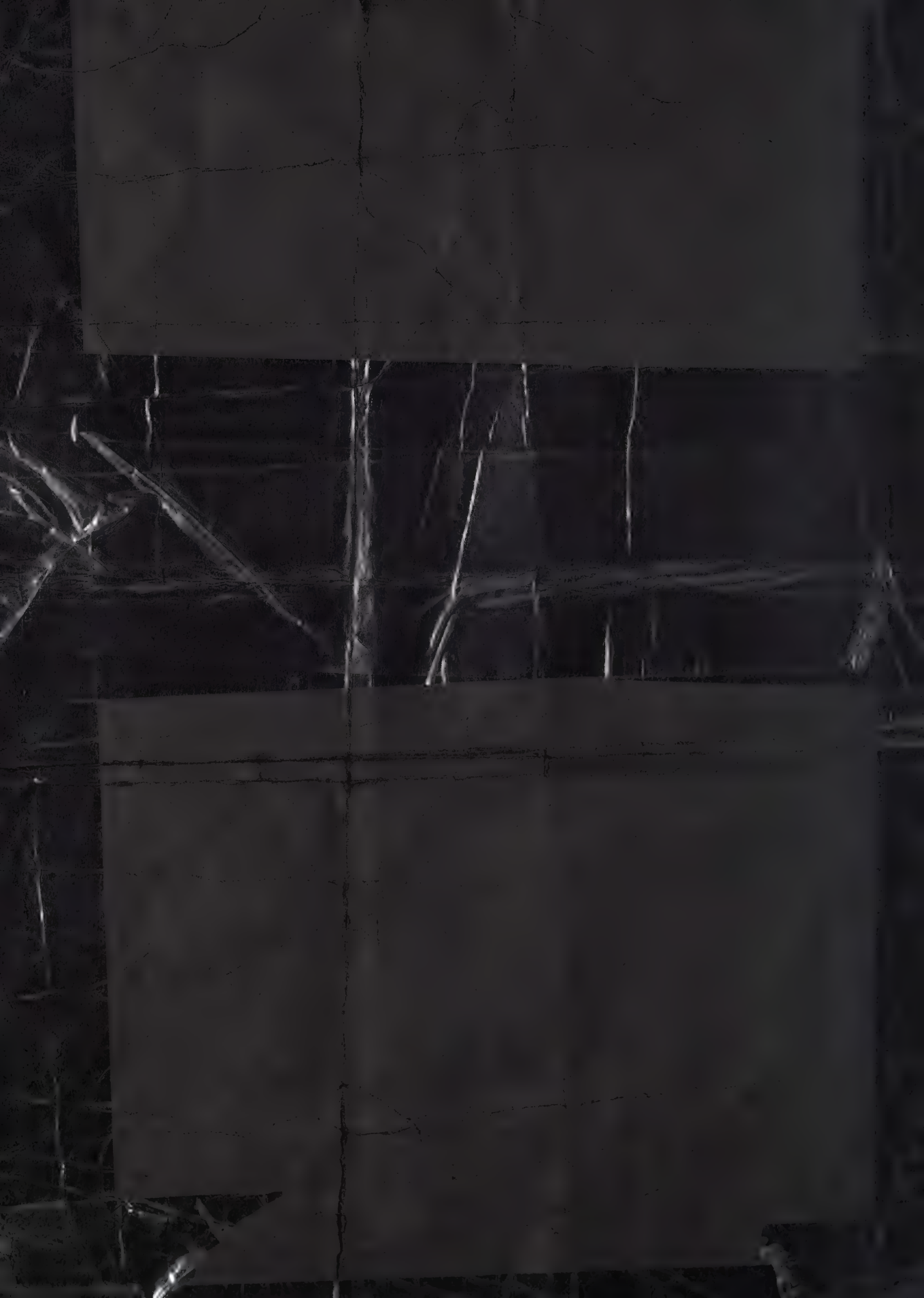
A. INSTALL THE NEW PC BOARD

1. Using the 5/16 wrench, secure the grounding plate at the left side of the board with the nuts.
2. Secure the board in place with nine screws.
3. Plug in the connectors as labelled.
   a. Verify they are fully seated on the board.

B. REPLACE COVER

1. Place the cover on the Power & Event Controller.
2. Secure with the four screws.





PROCEDURE 3: VERIFY OPERATION

1. Reconnect all devices previously disconnected from the Power & Event Controller.
2. Plug the power cord into the Power & Event Controller.
3. Turn the Power and Event and Controller's power ON.
   a. Wait for the Robot to initialize.

      Confirm Robot initialization by successfully entering and leaving the Robot teaching screen.
4. Go to the Power & Event Controller teaching screen.
5. Verify the device's operation. (Refer to the Power & Event Controller Performance Check.)

POWER AND EVENT CONTROLLER SPECIFICATIONS

A. Switched Outputs

Relays:	Reed switch, glass enclosed
Contact Ratings*:	0.5 Amps max. DC or AC RMS 24 Volts max. DC or AC RMS

*Power and Event Controllers shipped after July, 1985 have built-in contact protection.

B. Sensed Inputs (TTL Compatible)

Resistor:	4.7K Pullup
Voltage, open circuit:	5.0
Current, external switch closed:	1.0 ma

C. A/D Input

Input Range:	0-2.2V
Converter	
Scale Factor:	1.1mV ± 10%
Precision:	± 0.5% of full scale
High input impedance:	1.1 megohm
Sampling time:	0.5 sec nominal

D. AC Outputs (switched and variable)

Any combination of the switched and variable AC outputs may be used, not exceeding a total draw of 5 amps or 600VA (whichever is less).

A minimum load of 10VA should be used.

Leakage current (when switched off): 10ma

E. Power Supplies

5V:	1/2A
+12V (adjustable 2-15V)*:	1/2A (decreases as voltage decreases)
-12V (adjustable 2-15V)*:	1/2A (decreases as voltage decreases)
Power consumption:	0.33A plus the actual loads in any AC outlets used.

* ±12V may become unregulated at voltages above +12V or below -12V.

Printer

Section 1: Printer Performance Check

PRINTER
PERFORMANCE CHECK

TOOLS REQUIRED:

None

PROCEDURE SCOPE:

The following performance check is used to verify that the Printer IS or IS NOT functioning properly. This performance check verifies:

1. Communication between the Zymate Controller and the Printerbe
2. Printer Operation

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate.

PROCEDURE 1: COMMUNICATIONS CHECK

1. Turn the Controller's power OFF.
2. Plug the Printer module card into the support board on the Controller.
3. Connect the communications cable and power cord.
4. Turn the Printer's power ON.
5. Turn the Controller's power ON.

_____a. Wait for the Robot to initialize.

Confirm Robot initialization by successfully entering and leaving the Robot teaching screen.

CORRECTIVE ACTION

The Robot may fail to initialize if any system module is unplugged, turned off or operationally defective. Troubleshoot to find which module is defective by removing modules from the system in some sequence until the defective module is isolated.

To isolate the module:
1. **Turn the Controller's power OFF.**
2. **Remove all module cards from the Controller.**
3. **Plug in a single Zymate module card.**
4. **Turn the Controller's power ON.**
5. **Verify that the module initialized by displaying its teaching screen found under Bench and module setup.**
6. **Repeat 1-5 above for each module.**

WHEN THE DEFECTIVE MODULE HAS BEEN ISOLATED, REFER TO THE PERFORMANCE CHECK SECTION IN THE MANUAL FOR THAT MODULE FOR THE APPROPRIATE ACTION.

_____b. Select the Bench and module screen and verify that the Printer is listed.

CORRECTIVE ACTION

If the Printer is not listed as a module on the Bench and module setup screen, the module card, communication cable or module support board may be installed incorrectly or be defective.

1. **Make sure that all boards are firmly seated in their respective connectors.**
2. **Try alternate connectors.**
3. **If all else fails, replace the module card for the Printer.**

PROCEDURE 2: PRINTER OPERATION

TO PERFORM THIS CHECK, THE SELECT LIGHT (RED POWER LIGHT FOR HP INKJET) MUST BE ON AND THE PAPER LIGHT (YELLOW ATTENTION LIGHT FOR HP INKJET) MUST BE OFF (paper installed). An ALTERNATIVE printer check is described in Procedure 3.

1. Enable the printer using the appropriate function key on the Printer Setup screen.
2. Go to the Direct Control screen.

_____3. Verify that the prompt line appearing on the screen is printed on the printer.

4. Type: DIC and press RETURN.

_____5. Verify that the dictionary is listed on both the screen and the printer.

- **Refer to CORRECTIVE ACTION described under Procedure 3.**

PROCEDURE 3: PRINTER OPERATION – OPTIONAL CHECK

TO PERFORM THIS CHECK, THE SELECT LIGHT (RED POWER LIGHT FOR HP INKJET) MUST BE ON AND THE PAPER LIGHT (YELLOW ATTENTION LIGHT FOR HP INKJET) MUST BE OFF (paper installed). An ALTERNATIVE printer check is described in Procedure 2.

1. Display the Edit Program screen.
2. Press the PRINT PROGRAM function key.

   The program must exist in the EasyLab Program Directory.

_____3. Verify that the program is printed.

CORRECTIVE ACTION

- **Isolate the problem to either the printer or the interface:**

1. **Disconnect the printer from the Controller.**
2. **Perform the printer SELF-TEST:**
   a. **Turn the printer's power OFF.**
   b. **While turning the printer's power ON, hold in the LINE FEED key.**
   c. **Release the LINE FEED key after 2 seconds have elapsed.**
   d. **Verify that the printer prints its SELF-TEST character set.**
   e. **Press the FORM FEED key to stop the SELF-TEST. (For Okidata only.)**

- **If the printer does not perform the SELF-TEST, consult the TROUBLESHOOTING section of the manual supplied with the printer.**
- **If, after peforming any troubleshooting procedures indicated, the printer continues to fail to operate, replace the printer.**
- **If the SELF-TEST is performed successfully, the printer interface is defective. REPLACE the Printer's MODULE CARD and CABLE.**

Balance Interface

Section 1: Theory of Operation

Balance Interface Theory of Operation

Section 2: Performance

Balance Interface Performance Check

BALANCE INTERFACE
THEORY OF OPERATION

The Z850 Balance Interface accepts weight readings from balances compatible with the Mettler CL Interface. These balances include the Mettler series AE, PE, AC, or PC balances; the Mettler AK, HK, or PK balances; and the SETRA balance.

The Z851 Balance Interface accepts readings from balances having a compatible RS232 output option. These balances include the Mettler AE series and the Sartorius MP8 line of balances.

COMMUNICATION OF WEIGHT VALUES

The Zymate Controller can distinguish a stable weight from an unstable weight reading on balances equipped to communicate this information. Stability factors such as the number of decimal places to read and the time interval to look for a stable weight are set at the balance. This interface will also detect any errors that may occur in the communications.

The Zymate Controller will look for a stable weight (if so requested) to be sent by the balance by issuing a weigh request for a maximum 10 second duration. If a stable weight is not received within this time span, the Controller determines that an error conditions exists. A nonsensical weight value (-999) is reported.

The Zymate Controller can also accept unstable weight readings from the balance. This is done using the appropriate command variable. The initial reading upon a weigh request will be returned as the weight value.

BALANCE INTERFACE OPERATIONS

The Balance Interface has all the intelligence within it to perform taring and weighing operations as programmed by the operator.

TARING OPERATION

A TARE command by the Balance Interface does not electronically tare the balance. The Balance Interface stores the stable weight value obtained from the balance at the time of the reading. When a sample weight reading (stable or unstable) is requested, the tare value that was stored is subtracted from the weight reading just obtained from the balance and reported as the result of the sample weighing operation.

WEIGHING OPERATION

A weigh command by the Balance Interface looks for a stable or unstable weight reading value to be sent by the balance (as determined by the command variable used). When the weight reading is obtained, the value stored from the tare reading is subtracted from this value and the net result reported.

BALANCE INTERFACE PERFORMANCE CHECK

TOOLS REQUIRED:

None

PROCEDURE SCOPE:

The following performance check procedures may be used to verify that the Balance Interface IS or IS NOT functioning properly. This performance check verifies:

1. Communication between the Zymate Controller and the Balance
2. Balance Interface Operation

Any step having a "_____" preceding it determines a PASS/FAIL mode. If the action observed for that step is not what is expected, refer to the CORRECTIVE ACTION mentioned at the end of that section. Information to make minor corrections is provided where appropriate. Procedures for the replacement of parts are provided as well as in-depth troubleshooting information in this chapter of the Zymark Service Manual.

PROCEDURE 1: COMMUNICATIONS CHECK

1. Turn the Controller's power OFF.
2. Plug the Balance Interface module card into the support board on the Controller.
3. Connect the communications cable and power cord.
4. Turn the Balance's power ON.
5. Turn the Controller's power ON.

_____a. Wait for the Robot to initialize.

Confirm Robot initialization by successfully entering and leaving the Robot teaching screen.

CORRECTIVE ACTION

The Robot may fail to initialize if any system module is unplugged, turned off or operationally defective. Troubleshoot to find which module is defective by removing modules from the system in some sequence until the defective module is isolated.

To isolate the module:
1. Turn the Controller's power OFF.
2. Remove all module cards from the Controller.
3. Plug in a single Zymate module card.
4. Turn the Controller's power ON.
5. Verify that the module initialized by displaying its teaching screen found under Bench and module setup.
6. Repeat 1-5 above for each module.

WHEN THE DEFECTIVE MODULE HAS BEEN ISOLATED, REFER TO THE PERFORMANCE CHECK SECTION IN THE MANUAL FOR THAT MODULE FOR THE APPROPRIATE ACTION.

_____b. Select the Bench and module screen and verify that the Balance Interface is listed.

CORRECTIVE ACTION

If the Balance Interface is not listed as a module on the Bench and module setup screen, the module card, communication cable or module support board may be installed incorrectly or be defective.

1. Make sure that all boards are firmly seated in their respective connectors.
2. Try alternate connectors.
3. If all else fails, replace the module card for the Balance Interface.

PROCEDURE 2: BALANCE INTERFACE CHECK

NOTES:

- **Before proceeding, insure that the balance has been set according to specification to communicate in the Zymate System. Follow the instructions in the BALANCE'S manual to set these parameters!**
- **The following checks are done from the Balance Interface teaching screen.**

A. VERIFY WEIGHT READINGS

_____1. Verify that the balance type used with your Zymate System agrees with the one listed on the Balance Interface teaching screen.

CORRECTIVE ACTION

- **Select the proper balance type from the Balance Selection screen.**

2. Place an object to be weighed on the balance.
3. Press the DISPLAY RESULT function key on the Balance Interface screen.

_____4. Verify that the weight value displayed on the screen is the same as the weight displayed on the balance.

B. VERIFY THE TARE OPERATION

1. Place a vessel to be tared on the balance.
2. Press the TARE BALANCE function key.

_____3. Verify that the TARE WEIGHT value displayed on the screen is the same as the weight displayed on the balance.

C. VERIFY SAMPLE WEIGHT CALCULATION

1. Tare the balance as described in section B.
2. OPTIONAL: Place a sample in the vessel on the balance.
3. Press the DISPLAY RESULT function key.

_____4. Verify that the WEIGH RESULT displayed is:

WEIGH RESULT (CRT) = WEIGHT (balance) - TARE WEIGHT (CRT)

CORRECTIVE
ACTION

- If the "UNSTABLE READING" error message is displayed:

  Adjust the sensitivity of the balance. Consult the Balance manual for the adjustment procedure.

- If the "MODULE NOT RESPONDING" error message is displayed:

  Verify that a weight is displayed on the balance.

- If no weight is displayed, check to see if the balance is turned on.

  Verify that the balance is set to communicate with the Zymate Controller.

- Check the Balance Interface Specifications for the proper values. Consult the Balance manual for the adjustment procedures.

  Verify that the Communications Cable is connected properly.

- Verify that the balance operates properly when NOT connected to the Zymate System.

  If the balance does not operate properly by itself, the balance should be replaced.

  If the balance operates properly by itself, the Balance Interface may be defective. Replace the Balance Interface MODULE CARD and CABLE.

Z840 Computer Interface

Section 1: Theory of Operation

Z840 Computer Interface Theory of Operation

Section 2: Configuration

Configuring Z840 Interface Hardware

Z840 COMPUTER INTERFACE
THEORY OF OPERATION

INTRODUCTION

The Z840 Computer Interface Module allows the Zymate Controller to communicate with an external laboratory computer via an RS423 (RS232 compatible) serial link. The EasyLab language of the Zymate Controller provides a "command variable" facility which transfers numeric values from Zymate System Modules to variables in a mathematical expression. The results of a mathematical expression can also be transferred to a module using a command variable. The Computer Interface transfers these numeric values to or from the external computer.

The Z840 Computer Interface module supports baud rates of 110, 300, 600, 1200 and 2400. It supports odd, even or no parity. Zymate Controller software version 2.0 or higher is required to support this module.

Data Transfer

The Z840 Computer Interface is installed in the Zymate Controller as a system module. When a setup screen for the Computer Interface is selected, the operator can name the command variables which cause data to be transmitted or received over the interface. Using the setup screen, the operator can also set the serial link hardware parameters such as baud rate, parity and number of stop bits.

Once the hardware parameters have been set, the jumpers configured and the module command variables named, the Computer Interface is ready to transmit and receive data under program control. When the data input command variable is used, the Computer Interface module issues a data request message to the external computer and waits to receive a transmit message containing a numeric value which is passed to the Controller through a math expression. When the data output command variable is used, the Computer Interface issues a transmit message containing the numeric value to the external computer and waits for an acknowledgement message.

Data Format

All data is transferred in an ASCII display format, contained within a message package. The message package consists of the following fields:

Field Name	Length	Definition	Example
Message Header	1	Identifies the message type	T
Message ID	1	Identifies the message	3
Text Length	2	Provides length of text	07
Message Text	varies	Contains the numeric data	-493.48
Checksum	2	Checksum of all previous bytes	85
Terminator	2	Carriage return/line feed	crlf

The checksum is a modulo-256 addition of each byte in the message. It is converted to two ASCII characters for transmission. When no checksum is selected, the system ignores the field upon receipt of a message and transmits spaces for this portion of the message package.

Four types of messages are supported: transmit, receive, acknowledge (ACK) and not acknowledge (NAK).

- The TRANSMIT message uses the complete format shown above with the letter "T" as the message header.
- The RECEIVE message uses the format above with a text length of "00", no text field, and the letter "R" as the message header. After sending the receive message, the Computer Interface expects to receive a transmit message containing the numeric data in the text field, and a message ID which matches the ID of the receive request.
- The ACKNOWLEDGE message uses the format above with a text length of "00", no text field and the letter "A" as the message header. The ID field of the acknowledge message must match the ID field of the message being acknowledged.
- The NOT ACKNOWLEDGE message is sent in response to an improperly received message of any type. The text length is "00", no text field is sent, the letter "N" is the message header, and the message ID is set to "0".

All communication is initiated by the Computer Interface module. Each communication sequence will carry a Message ID sent by the Zymate System.

Typical sequences for data transmission are:

Numeric data from external computer to Zymate System

- Zymate Controller sends a receive message with an ID of "5".
- External computer sends a transmit message with an ID of "5".
- After checking message received, Zymate Controller sends an ACK message with an ID of "5".

Numeric data from Zymate System to external computer

- Zymate Controller sends a transmit message with an ID of "7".
- External computer sends an ACK message with an ID of "7".

If a message is not properly received, a NAK message is transmitted. If the Zymate Controller transmits the NAK, it restarts the entire message exchange sequence from the beginning. The external computer does not respond to the NAK message. If the external computer sends a NAK message, the Zymate Controller repeats the message exchange sequence from the beginning. The external computer does not retransmit any message without a request to do so.

CONFIGURING THE Z840 COMPUTER INTERFACE HARDWARE

There are six jumpers on the Computer Interface module card to facilitate configuration of the communications line with the external computer. These jumpers are arranged to the following table:

Communications Configuration Table

Signal Name	Jumper Position	Cable Jumper Position	25 Pin Connector No.
TXD	E1	E3	2
RXD	E4	E2	3
DSR	E7	E6	–
DTR	E5	E8	–
CTS	E11	E10	5
RTS	E9	E12	4
Signal Ground	–	–	7
Shield Ground	–	–	1

The module card is jumpered as follows on shipment:

E1 to E2
E3 to E4
E5 to E7
E6 to E8
E9 to E11
E10 to E12

To reverse TXD/RXD:

Alter the jumper arrangement as follows:

E1 to E3
E2 to E4

To set up RTS/CTS protocol:

Alter the jumper arrangement as follows:

E9 to E10
E11 to E12

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